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PUBLIC DOCUMENT . . . . No. 4.

FORTY-SECOND

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

STATE BOARD OF AGRICULTURE,

TOGETHER WITH THE

TWELFTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

1894.

BOSTON:
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1895.

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STATE BOARD OF AGRICULTURE, 1895.

Members ex Officio.

HIS EXCELLENCY FREDERIC T. GREENHALGE.
HIS HONOR ROGER WOLCOTT.
HON. WM. M. OLIN, *Secretary of the Commonwealth.*
H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*
C. A. GOESSMANN, PH.D., LL.D., *Chemist of the Board.*
WM. R. SESSIONS, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term Expires.
JAMES S. GRINNELL of Greenfield,	1896
SPRAGUE S. STETSON of Lakeville,	1897
DWIGHT A. HORTON of Northampton,	1898

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agr'l and Hort'l),	F. W. SARGENT of Amesbury,	1897
Attleborough (Agr'l Assoc'n),	ISAAC ALGER of Attleborough,	1897
Barnstable County,	JOHN BURSLEY of West Barnstable,	1898
Berkshire,	SAMUEL M. RAYMOND of Hinsdale,	1897
Blackstone Valley,	HENRY A. COOK of Northbridge (P. O. Whitinsville),	1897
Bristol County,	N. W. SHAW of North Raynham,	1896
Deerfield Valley,	CHAS. E. WARD of Buckland,	1896
Eastern Hampden,	W. M. TUCKER of Monson,	1897
Essex,	F. H. APPLETON of Peabody (P. O. Lynnfield),	1896
Franklin County,	GEO. E. TAYLOR of Shelburne,	1898
Hampden,	F. E. CLARK of Wilbraham,	1897
Hampshire,	WM. P. BROOKS of Amherst,	1898
Hampshire, Franklin and Hampden,	C B. LYMAN of Southampton,	1897
Highland,	H. A. BARTON, JR., of Dalton,	1896
Hillside,	WM. BANCROFT of Chesterfield,	1896
Hingham (Agr'l and Hort'l),	EDMUND HERSEY of Hingham,	1897
Hoosac Valley,	WM. H. GOVE of North Adams (P. O. Blackinton),	1897
Housatonic,	F. A. PALMER of Stockbridge,	1897
Marshfield (Agr'l and Hort'l),	JOHN H. BOURNE of Marshfield,	1897
Martha's Vineyard,	H. G. NORTON of West Tisbury,	1898
Massachusetts Horticultural,	E. W. WOOD of West Newton,	1897
Massachusetts Society for Promoting Agriculture,	FRANCIS SHAW of Wayland,	1897
Middlesex North,	A. C. VARNUM of Lowell,	1898
Middlesex South,	ISAAC DAMON of Wayland (P. O. Cochituate),	1896
Nantucket,	J. S. APPLETON, JR., of Nantucket,	1897
Oxford,	W. M. WELLINGTON of Oxford,	1898
Plymouth County,	AUGUSTUS PRATT of No. Middleborough,	1896
Spencer (Far's and Mech's Assoc'n),	JOHN G. AVERY of Spencer,	1898
Union (Agr'l and Hort'l),	CURTIS M. BLAIR of Blandford,	1898
Weymouth (Agr'l and Ind'l),	QUINCY L. REED of South Weymouth,	1897
Worcester,	C. L. HARTSHORN of Worcester,	1896
Worcester East,	W. A. KILBOURN of South Lancaster,	1897
Worcester North,	GEORGE CRUICKSHANKS of Fitchburg,	1896
Worcester North-west (Agr'l and Mech'l),	A. D. RAYMOND of Royalston,	1898
Worcester South,	G. L. CLEMENCE of Southbridge (P. O. Globe Village),	1898
Worcester County West,	E. A. HARWOOD of North Brookfield,	1896

THE FORTY-SECOND ANNUAL REPORT

OF THE

SECRETARY

OF THE

BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The season of 1894 was quite generally considered a poor one for the farmers. None of our crop correspondents, in their returns to this office, November 1, spoke of it as unusually profitable, while the large majority considered it either unprofitable or only fairly profitable. The unfavorable conditions were largely due to the drought of summer and early fall, which shortened nearly all crops, and in some sections reduced them very materially. There was also much complaint of slow sales and low prices. One correspondent attributed this latter fact to so many men being out of work, thus shortening the local markets.

MASSACHUSETTS WEATHER, 1894.

[Compiled from data furnished by the New England Weather Service.]

January was warm and dry. The highest temperature was on the 24th and 25th, varying from 47° to 57°; and the lowest was on the 13th and 29th, when it was from 8° above zero on the coast to 9° below zero in the interior counties. The precipitation was generally deficient. Most of the snow fell on the 27th and 30th. During the greater part of the month the ground was mostly bare.

February was very cold, and decidedly the "winter month" of the year. The precipitation was more than usual along the coast and deficient in the interior, and was mostly in the form of snow. The highest temperature occurred in most places on the 18th, and was from 42° to 54°. The coldest day of the month, and in many places the coldest for years, was the 24th. The temperature ranged from 5° to 12° above zero along the coast, while in the western part of the State it did not rise above 4° to 11° below zero. On the 17th and 18th there was a change of 71° within thirty-six hours.

March was very warm and very dry. The excess of temperature averaged over 8° a day at Boston, Cambridge, Somerset, Fitchburg and Springfield. At a few stations along the coast the highest temperature was on the 6th, but generally it was on the 19th, and varied from 60° to 74°. The coldest spell was on the 27th and 28th, when the temperature fell from 8° to 20° below freezing. It was the dryest March on record in the history of the Weather Bureau at Boston. The snowfall was small, and the ground was bare the most of the month.

April was warm and dry in all interior sections, and cool and wet along the south-eastern coast. The warmest day was generally on the 27th, the temperature rising to from 72° to 82°. The lowest was everywhere on the 3d, when it fell to from 5° to 20° below freezing. Snow fell on the 9th, 11th and 12th. High gales prevailed, and with the damp, heavy snow did great damage to telegraph and telephone service.

May as a whole was favorable for cultivation and growth of crops. Beginning on the 18th, the drought was effectually broken by rain, and for the rest of the month mostly cloudy, cool weather prevailed, with frequent rains. Quite a good deal of damage was done in eastern sections by high winds, and in all sections by frosts which occurred on the 11th, 12th, 15th, 16th, 17th and 22d. Hail fell at Dudley on the 4th. Winds mostly south-west. Thunder-storms occurred on the 2d, 4th, 7th, 18th, 19th and 28th.

During June in most of the western counties frequent and generally sufficient showers occurred. But little rain fell in the eastern part of the State. The highest temperature reported was 103°, at Lowell on the 17th. Light frosts occurred on the morning of the 14th in the south-east. The prevailing wind was south-west. Drought conditions were reported in places. Hail fell at Hyannis on the 4th. Thunder-storms occurred on the 4th, 7th, 11th, 21st, 23d and 30th.

July weather on the whole was favorable for harvesting hay and grain; but the heat on some of the last days of the month was intense, and there was a general lack of precipitation in all eastern sections, giving one of the most serious and long-continued droughts on record. At many of the interior towns reliable thermometers registered over 100° on the 20th. In the western part of the State the rainfall was generally sufficient for vegetation. The prevailing wind was south-west. Thunder-storms occurred on the 1st, 3d, 5th, 10th, 14th, 15th, 16th, 17th, 18th, 21st, 25th, 29th and 31st. Hail was reported at Worcester the 25th and at Fitchburg the 29th.

August weather was cool. There were few rainy and cloudy days, and an unusual lack of rainfall. The drought was reported as serious in all sections of the State. A frost on the 22d was general throughout the State. Hail was reported at Concord on the 19th. The prevailing wind was south-west. Thunder-storms were reported on the 3d, 9th, 15th, 19th and 20th.

September weather was generally favorable for ripening and harvesting crops. The weather was warmer than usual, the warmest spells being on the 9th–11th, and the coldest on the 26th–27th. On the last-named dates were killing frosts on all low lands. The prevailing wind was south-west. Thunder-storms occurred on the 10th, 15th, 16th, 17th. A heavy thunder and wind storm passed easterly across the northern part of the State on the 10th. A storm on the 30th whipped off many apples along the coast.

October weather was warmer than usual, with a marked excess of precipitation in the south-eastern districts and a slight excess in central and western. The 20th was the warmest day, the maximum being higher than is usual so late in the season. Light frosts were general, and killing frosts occurred on all low lands, but in most of the upland or protected districts hardy garden plants and late vegetables were growing at the close of the month, untouched by frosts. The prevailing wind was west. The rainfall was abundant in all sections for growth of grass and grain seeds and for ploughing and seeding; but except in the extreme south-east there had not been enough to fill up wells and springs to any extent. The first snow of the season fell on the evening of the 14th, in the Berkshire hills, in the north-eastern part of the State. Enough came on this date and also on the 17th to whiten the ground, but it soon melted. The thunder-storm on the evening of the 13th was quite severe in south-eastern districts. At Taunton the storm was accompanied by very heavy rain, 1.75 inches falling in three-fourths of an hour.

November was decidedly a wintry month, with a slight excess of rainfall in south-eastern districts and a deficiency in western. It was much colder than the normal. At Blue Hill it was pronounced the coldest November in the past ten years. At Monroe it was the coldest in seven years of observation. The first three days of the month were the warmest and the 20th and 30th the coldest at most places. At Boston this year gave the coldest Thanksgiving Day since 1873. The cold wave on the 6th–7th following the severe snow-storm gave the first killing frost of the season at a number of places in the State.

The storm of the 5th–6th gave its heaviest snow about thirty miles from the coast, but it was a most severe storm throughout the State. Telegraph and telephone poles and wires especially suffered, and went down by hundreds and almost thousands. Fruit trees were heavily coated with ice and snow, and were much damaged. The voluntary observer at Taunton reported it the worst storm ever known in that city. At Hyannis the wind was reported by old residents to be the hardest ever known; chimneys, trees, fences and out-buildings were thrown down. G. E. Fuller, M.D., of Monson, reported it the hardest storm of the kind in twenty-six years.

On the extreme coast only a trace to one inch of snow came, but in most sections the amount was from two to twelve inches. The ground was well covered, and no damage is expected from the cold weather. A great deal of fruit and garden truck was caught out in the storm of the 5th–6th, much of it remaining until the warm spell after the 14th.

December was slightly colder than usual in vicinity of Fitchburg and on southern coast near New Bedford, but generally the month may be pronounced mild, with the frost mostly out of the ground in places during the middle of the month. The last few days of the month were very cold in all sections.

In the north-western part of the State the precipitation was very nearly normal or slightly below, but in south-eastern districts there was a marked excess. The storm of the 26th–27th was responsible for this excess in precipitation, as it gave unusually heavy rain over most of the south-eastern part of the State. Over a narrow area running from New Bedford to Plymouth the fall of snow and rain in this storm was over three inches, while it was over two inches throughout Barnstable, Nantucket, Dukes, Plymouth, Bristol, Norfolk, Suffolk and eastern Worcester, Middlesex and Essex counties. The wind accompanying the storm was of almost hurricane force.

The snowfall amounted to from two to twenty-one inches. Little more than a trace of this was on the ground on the 15th, but at the end of the month the snow covering amounted to four to eight inches, except along the immediate coast. The ground was well protected by snow throughout all the coldest weather.

The following summary of the weather of 1894 is furnished by the Hatch Experiment Station, Amherst, Mass. : —

Annual Summary for 1894.

Pressure (in Inches).

Actual maximum reading, 30.47, Jan. 17, 10 P.M.
Actual minimum reading, 28.59, Jan. 30, 6 A.M.
Mean reduced to sea level, 30.085.
Annual range, 1.88.

*Air Temperature (in Degrees F.).**

Highest, 97.; 98, July 20.
Lowest, —9.; —17, Feb. 25.
Mean, 49.7; 47.9.
Annual range, 106.; 115.
Highest mean daily, 82.5; 84, July 28.
Lowest mean daily, 1.; —1.5, Feb. 24.
Mean maximum, 57.7; 59.6.
Mean minimum, 38.; 36.9.
Mean daily range, 16.5; 22.7.
Greatest daily range, 35, May 12; 47.5 Feb. 17.
Least daily range, 2.; 5.; Oct. 25.

Humidity.

Mean dew point, 40.5.
Mean force of vapor, .4416.
Mean relative humidity, 71.9.

Wind, Prevailing Directions (per Cent).

South-west, 17.
South, 15.
North, 15.
North-west, 13.
Total movement, 36,257 miles.
Greatest daily movement, 443 miles, April 13.
Least daily movement, 0 miles, Sept. 29.
Mean daily movement, 99.4 miles.
Mean hourly velocity, 4.1 miles.
Max. pressure per square foot, 22½ pounds = 67 miles per hour, Feb. 23 at 2 P.M.

Precipitation.

Total rainfall or melted snow, 32.64.
Number of days on which .01 inch of rain or melted snow fell, 125.
Total snowfall in inches, 71½.

Weather.

Mean cloudiness observed, 50.5 per cent.
Total cloudiness recorded by the sun thermometer, 2,488 hours or 54.9 per cent.
Number of clear days, 107.
Number of fair days, 83.
Number of cloudy days, 175.

Bright Sunshine.

Number of hours recorded, 2,051.
Mean ozone, 24.9 per cent.

Dates of Frosts.

Last, May 22.
First, Aug. 22.

Dates of Snow.

Last, April 12.
First, Nov. 5.

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* The first figures denote reading at top of tower, the second at base.

Crops of the Year.

The season opened from ten days to two weeks earlier than usual; but the dry weather of April and the first half of May, and the cold storms and frosts following, made conditions about average on June 1. Stock wintered well. Promise of good crop of hay on newly seeded and moist lands, and for a light to fair crop on old and dry fields. Fall seeding wintered well. The apple bloom was unusually heavy, the peach bloom light, and the bloom of other fruit trees and small fruits a good average. Canker and cut worms unusually numerous; tent caterpillars not plenty. Farm help more plenty than of late years. Wages ranged from $8 to $28 per month and board, according to locality and character of help; per day the range was $1 to $2, with

$1.50 as the average. The general industrial depression as yet had had no material influence on the acreage of crops.

July 1 the potato beetle appeared to be the only insect generally prevalent. Indian corn was looking well, though backward, and a slight increase in acreage was reported. Haying was just commencing. Early potatoes reported as looking well, with promise of a good crop; a considerable increase in acreage was noted. Early market-garden crops were generally a fair yield, with prices somewhat lower than usual. Dairy products were average in quantity, with slight but general decrease in prices received. Pastures reported as "dry," "short" or "badly in need of rain." The outlook for fruits and berries was fair. Strawberries were a fair crop, currants a good crop and cherries abundant; blackberries and raspberries promised well.

August 1 the potato beetle and the horn fly were most frequently mentioned as prevalent and troublesome. A good crop of Indian corn promised. Hay crop harvested generally in excellent condition, and quality as a rule very good. Yield estimated as three-fourths of an average crop. Fodder corn reported as the forage crop most universally grown. Market-garden crops below average in quantity, with prices low. Early potatoes light yield and quite small, but of good quality; prices low. Apples and pears generally promised well; grapes fair to good; few peaches promised; cranberries promised a light crop. Pastures "very short," "crisp," "dry" and "badly burned." Rye a good average crop. Oats injured by dry weather, and considerably rusty.

September 1 Indian corn promised about a three-fourths crop. The drought badly injured potatoes. Tobacco a very fair crop, of good color and quality. Apples and pears very uneven; very few peaches; grapes a fair crop; cranberries light. Pasturage in all sections very poor. Oats and barley suffered considerably from drought, and fell short of average crops.

October 1 Indian corn about a three-fourths crop; rowen almost a total failure. Fall feed considerably improved, but still far from average condition. Less than usual amount of fall seeding done, owing to dry weather. Onions as a rule a light crop, owing to drought. Potatoes generally considerably less than an average crop, but of good quality. Root crops promised to be only fair; turnips particularly poor. Apple crop very uneven; apples generally of large size and fine color. Cranberries not over half a crop.

November 1, fifty-three correspondents reported root crops as less than average and forty-four as average or above. Turnips, particularly, were referred to as poor. The majority of correspondents referred to farm stock as in good condition, and the remainder as fair or rather thin in flesh but otherwise in good condition. Fall seeding was reported as hardly up to an average condition, although improvement had been made during the month.

The majority of correspondents spoke of apples as average, a few as above average, and a slightly larger number as below. Prices quoted ranged from $1 to $1.50 per barrel; probably $1.25 was a fair average of the prices given. About two-thirds of the correspondents considered the crop a profitable one, while the other one-third looked upon it as unprofitable. Among the reasons given for lack of profit were the high cost and scarcity of barrels, the high price of labor and land, poor methods of orcharding and the unusually large crop.

Most Profitable Crops.

The opinions of correspondents as to the most profitable crops varied widely. Some stated that they could not tell, as sales were not yet completed, while one said that there had been no profitable crops. Thirty-eight considered hay to have been among the most profitable crops; thirty-three, potatoes; twenty-four, corn; eighteen, apples; four, tobacco; three, cabbage; three, fruit; two, rye; two, oats; two, barley; two, cranberries; two, peas; two, asparagus; and one, dairy products.

Least Profitable Crops.

Twenty-seven correspondents stated that potatoes were among the least profitable crops; eighteen, corn; eight, hay; seven, oats; six, onions; five, apples; four, roots;

four, cabbage; three, milk; three, market-garden crops; two, tobacco; two, rye; two, strawberries; one, peas; one fruits; one, barley; one, pears; one, wheat; one, cranberries; and one, beans.

Profits of the Season.

The season was quite generally considered to have been a poor one for the farmer. No correspondent spoke of it as unusually profitable, while the great majority considered it either unprofitable or only fairly so. The unfavorable condition was largely due to the drought of summer and early fall, which shortened nearly all crops, and in some sections reduced them nearly to a minimum. There was also much complaint of slow sales and low prices.

Massachusetts Crop Reports.

The publication of monthly crop bulletins was continued as in previous seasons, and six in all were issued (May–October), aggregating 192 pages of printed matter. Two thousand copies of Nos. 1 and 2, 2,200 copies of Nos. 3, 4 and 5, and 2,500 copies of No. 6 were printed and distributed. The bulletins were made up as in 1893. The special subjects treated were: Bulletin No. 1, "Report on farm animals," "Communication to fruit growers, dealers and consumers;" Bulletin No. 2, "Tuberculosis and its eradication;" Bulletin No. 3, "The diagnosis and eradication of tuberculosis;" Bulletin No. 4, "Retrospect and prospect of the fruit crop of 1894," "Statistics of Massachusetts agriculture;" "Bulletin No. 5, "The regulative influence exerted by birds on the increase of insect pests;" Bulletin No. 6, "Household insects." Also, as in the past two years, this office co-operated with the New England Weather Service in the issuing of weekly weather-crop bulletins. The first was of date of April 30 and the last of date of October 1, twenty-three in all, representing an aggregate issue of 46,000 copies.

PUBLICATIONS.

The following publications were issued under the supervision of this office during the calendar year 1894: —

	Pages.	Number.	Date of Issue.
Agriculture of Massachusetts, 1893, . .	898*	15,000	April 17
Crop Bulletin, No. 1, May, ...	32	2,000	June 7
" " No. 2, June, ...	32	2,000	July 7
" " No. 3, July, ...	32	2,200	August 8
" " No. 4, August, . . .	32	2,200	Sept. 8
" " No. 5, September, . . .	32	2,200	Oct. 10
" " No. 6, October, . . .	32	2,500	Nov. 8
Regulations of Board, speakers and subjects, farmers' institutes, ...	7	500	Nov. 4
Catalogue of Abandoned or Partially Abandoned Farms, Fifth edition, . . .	161	2,000	Dec. 27

* Including annual report of Director of State Agricultural Experiment Station, 407 pages.

LEGISLATION.

The legislation of the year 1894 that had reference to the Board of Agriculture or to the agricultural societies was: "An Act to authorize the Hillside Agricultural Society to hold additional real and personal estate" (Acts of 1894, chapter 43); "An act relating to the membership of the State Board of Agriculture" (Acts of 1894, chapter 144); a "Resolve providing for printing the special report of the State Board of Agriculture on the work of the extermination of the ocneria dispar or gypsy moth" (Resolves of 1894, chapter 9); a "Resolve providing against depredations by the insect known as the ocneria dispar or gypsy moth" (Resolves of 1894, chapter 71); a "Resolution concerning the extermination of the gypsy moth."

APPROPRIATIONS.

OBJECTS FOR WHICH APPROPRIATED.	1892.		1893.		1894.		1895.
	Appropriated.	Used.	Appropriated.	Used.	Appropriated.	Used.	Appropriated.
Bounties to societies, . .	$21,500 00	$21,352 49	$21,000 00	$20,982 45	$21,000 00	$20,629 80	$21,000 00
Travelling and necessary expenses of the Board, . .	1,900 00	1,516 39	1,900 00	1,630 77	1,900 00	1,787 85	1,900 00
Travelling and necessary expenses of the secretary, .	500 00	500 00	500 00	459 22	500 00	490 46	500 00
Incidentals in office of secretary, . .	500 00	500 00	600 00	600 00	700 00	700 00	700 00
Salaries of secretary and clerks, . .	5,100 00	5,100 00	5,300 00	5,300 00	5,300 00	5,300 00	5,300 00
Dissemination of useful information in agriculture by means of lectures or otherwise, . .	2,200 00	2,148 06	2,550 00	2,550 00	2,650 00	2,650 00	2,650 00
Printing 15,000 copies of the "Agriculture of Massachusetts," . .	5,897 58	5,897 58	6,052 26	6,052 26	5,965 67	5,965 67	*6,000 00
Collecting and circulating information relative to abandoned farms, . .	†1,323 38	164 88	1,000 00	280 78	†719 22	644 23	
Carrying forward work of Dairy Bureau,	4,000 00	3,427 51	4,000 00	3,336 90	4,000 00	4,000 00	7,000 00
Salary of executive officer of Dairy Bureau,	500 00	500 00	500 00	500 00	500 00	500 00	500 00
Salary of assistant in work of Dairy Bureau,	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00
Nails or spikes for marking shade trees for preservation, .	100 00	48 42	100 00	100 00	200 00	198 72	200 00
Printing 5,000 copies synoptical and analytical index, to the "Agriculture of Massachusetts," . .	-	-	1,400 00	1,400 00	‡393 36	393 36	-
Aggregates, .	$44,720 96	$42,355 33	$46,102 26	$44,392 38	$45,028 25	$44,460 09	$46,950 00

* Estimated. † Balance. ‡ Deficiency.

Also, $100,000 was appropriated to be used in the extermination of the gypsy moth. An appropriation of $200,000 for this work has been asked of the Legislature of 1895.

NAILS FOR MARKING TREES.

The work of supplying nails or spikes for the marking for preservation of shade trees within the limits of highways, under the provisions of chapter 196 of the Acts of 1890, has been continued. The annual appropriation of $100 being used up before the prorogation of the Legislature, an additional $100 was asked for and granted. Nails in varying quantities have been supplied, on application, to the cities of Fitchburg, Marlborough and Worcester, and to the towns of Barre, Boxford, Bourne, Charlton, Chelmsford, Framingham, Goshen, Harvard, Hardwick, Lancaster, Leominster, Mashpee, New Salem, Northbridge, Pepperell, Sandwich, Stow, Sunderland, Swansea, Tyngsborough and Winchendon. Since the work of supplying these nails was begun, Dec. 26, 1891, 3 cities and 44 towns have availed themselves of the provisions of the act. In all there have been furnished to date 6,226 three and one-quarter inch nails; 43,660 two and three-fourths inch nails, and 31,458 two and one-quarter inch nails, making a total of 81,344.

ABANDONED FARMS.

The "Act to authorize the State Board of Agriculture to collect and circulate information relating to abandoned farms" was approved May 4, 1891 (Acts of 1891, chapter 280). Under this act four editions of a catalogue of abandoned or partially abandoned farms were issued previous to the year 1894, an account of which appeared in the secretary's report for 1893. The fourth edition not being sufficient to supply the demand for the catalogues, it was decided in July, 1894, to issue a fifth edition. To make this edition as exhaustive as possible, the executive committee decided to call upon the members of the Board for their personal assistance. The members of the Board gave valuable assistance, and reported 541 new farms. Twenty-four new farms were reported from other sources, making a total of 565. As a partial result of this work, 143 new descriptions were received, and were included in the catalogue as an addenda to the fifth edition.

A summary of the work of this office to date shows the following results: —

COUNTIES.	Number of Abandoned or Partially Abandoned Farms reported.	Number of Owners or Agents making reply.	Number not replying to Request for Description.	Number stating They did not care to sell.	Number reporting Informant to have been misinformed.	Number of Letters returned unclaimed by Post Office Department.	Number of Farms reported sold in Reply to Request for Description.	Number of Descriptions of Farms received.	Number of Descriptions withdrawn from Catalogue.	Number of Advertised Farms sold.
Berkshire, . .	258	141	117	10	12	19	5	114	8	27
Franklin, . .	165	77	88	11	10	8	3	53	11	20
Hampshire, . .	145	65	80	13	5	7	3	44	9	12
Hampden, . .	207	104	103	16	6	3	3	79	8	19
Worcester, . .	423	239	184	28	37	20	20	154	27	41
Middlesex, . .	58	31	27	4	4	4	3	20	4	6
Essex, . . .	12	4	8	2	–	2	–	2	–	1
Suffolk, . . .	–	–	–	–	–	–	–	–	–	–
Norfolk, . .	44	29	15	5	6	5	3	15	3	6
Bristol, . . .	100	37	63	13	7	7	2	15	2	3
Plymouth, . .	85	35	50	4	1	2	4	26	5	13
Barnstable, . .	45	16	29	2	1	3	1	12	1	1
Dukes, . . .	11	9	2	2	1	–	–	6	1	–
Nantucket, . .	10	6	4	2	1	–	–	3	–	1
Aggregates, .	1,563	793	770	112	91	80	47	543	79	150

Up to December 1, returns have been received concerning 354 of the 400 farms described in the four editions of the catalogue. Of these, 150 owners reported their farm sold, 79 wished for various reasons to have the description of their farm withdrawn from the catalogue, and 125 wished the description of their farm continued in the fifth edition. Nothing was heard concerning 46 farms.

The preceding table shows the location by county of the farms sold and withdrawn, and the descriptions of these farms were marked with red ink. One object of this method of designating farms sold or withdrawn was to save expense, as the pages of descriptions were stereotyped when set up; and another object was to show at a glance just what has been done.

Unquestionably a large majority of the purchasers of these farms are of American parentage. The returns showing nationality were not as full as wished, but the names substantiate the above statement.

Ninety purchasers were residents of Massachusetts at the time of purchase, 5 of New York, 5 of Connecticut, 2 of New Hampshire, 2 of Florida, 2 of Ohio, 1 of Rhode Island, 1 of New Jersey and 1 of Nova Scotia, while the residence of 41 was not reported. Fifty-six of the farms sold were reported as sold for farming purposes, 14 for a home, 11 for an investment, 5 for farming purposes and poultry raising, 6 for dairying and stock raising, 5 for summer residence, 4 for poultry raising, 2 for sheep raising, 1 for poultry raising and market gardening, 1 for cranberry culture, 1 for the wood and lumber, while the intentions of 44 purchasers were not obtained.

By the State census of 1885 there were 45,010 farms in the State, representing a total acreage of 3,898,429¼; average acreage, 86.61; total value of lands and buildings, $185,118,925; average value of lands and buildings, $4,112.83.

The total acreage of the 543 farms advertised in the catalogue is 61,763½; average acreage, 113.72; total amount asked for the farms, $907,030; and average amount asked for the farms, $1,670.40.

The total acreage of the 150 farms reported sold is 15,110½, or an average acreage of 100.73. The 150 farms sold for a total of $229,125, or an average of $1,527.50.

The total acreage of the 79 farms withdrawn is $8{,}003\frac{7}{40}$, or an average of 101.30. The 79 farms withdrawn were valued at $125,925, or an average of $1,593.98.

The cost of this work has been comparatively slight, as will be seen by the following statement: —

Appropriation under chapter 280, Acts of 1891, .	$2,000 00	
Amount unused and reverting back to State treasury at the end of two years, Dec. 31, 1892, .	858 50	
	$1,141 50	
Appropriation under chapter 46, Resolves of 1893,	1,000 00	$2,141 50
Printing 10,500 catalogues, five editions, . .	$1,233 01	
Special envelopes for mailing, ...	138 73	
Postage stamps, ...	435 00	
Printed circulars, ...	57 97	
Advertising, ...	3 50	
Express, ...	2 00	
Special services members Board of Agriculture, .	196 30	2,066 51
Balance Dec. 31, 1894, reverting back to State treasury, ...		$74 99

TUBERCULOSIS.

The dairy interest is by far the most important of any branch of agriculture of Massachusetts. Notwithstanding the competition of the west and the northern New England States, our dairymen have heretofore been able to continue the business, though, on account of the high prices of grain, which is largely purchased, the high prices that must be paid for labor and the ever-increasing taxes upon real estate and live stock, the profits have been small. Now the dairymen and cattle owners are confronted with a disease, tuberculosis, amongst the neat stock, which, under the present policy of the State, bids fair to make cattle raising and dairying a losing business. This disease is among us through no fault of the cattle owners, and, while they would welcome the examination of their herds and the destruction of those animals that are manifestly ailing, they stand aghast at the prospect of having their herds decimated by the condemnation of large numbers of cattle to all appearances in good health.

It is true that the State law provides for the payment to the cattle owners of one-half the health value for food or milk purposes of animals thus condemned, but this allowance will not purchase successors to the animals destroyed. Then, again, the full value of the animals condemned is but part of the loss to the owner. His business is broken into, his herd discredited and his customers made afraid of his product. The farmers of Massachusetts are ready to bear their full share of the public burdens; but when we investigate this question we can but conclude that under the present law they are called on to bear much more than their share. These cattle are killed to guard the public health. While the tuberculin test is admitted to be quite reliable and its use justifiable as a safeguard to public health, it is contended that it condemns many cattle that might never become diseased in the common acceptation of the term, and would never become dangerous to the public health. Tuberculosis in cattle has been proved to be identical with consumption in mankind, and we have a right to reason from what we know of consumption. I quote from "Tuberculosis in relation to animal industry and public health," by Dr. James Law: "Dr. Briggs tells us . . . that in the charity hospital of the city (New York) thirty per cent of all deaths show old lesions of tuberculosis now become stationary." He quotes a Vienna hospital pathologist to the effect that he finds similar old stationary lesions in eighty-five per cent of all post-mortem examinations. Is it too much to claim that a like proportion of bovines slightly affected with tuberculosis would never be injured by it? Can there be any question that such cases if condemned should be paid for in full? The public health must be guarded, but the cost should be borne by the public, and not by one class of the people.

The situation is a serious one for the agriculture of the State. The neat stock of the State is rapidly decreasing, the decrease having begun with the agitation of the danger from tuberculosis. In 1890, 200,658 cows and 62,549 neat cattle other than cows were assessed; in 1894, 182,477 cows and 41,059 neat cattle other than cows were assessed; a decrease of 18,181 cows and of 21,490 in other neat cattle, making a total decrease in four years of 39,671, or 19 per cent. The number of cows in the State had been previously quite steadily increasing for thirty years, from 149,090 in 1861 to 200,658 in 1890.

Gypsy Moth (*Ocneria dispar*).

The Legislature of 1894 appropriated $100,000 for the continuation of the work of exterminating this pest, and the report of the committee in charge will be found printed on pages 235–270 of this volume. At the annual meeting, Feb. 6, 1895, the following committee was elected to have charge of the work for the present year: Messrs. E. W. Wood of West Newton, Augustus Pratt of North Middleborough, F. W. Sargent of Amesbury, S. S. Stetson of Lakeville, John G. Avery of Spencer and the secretary.

Dairy Bureau.

No change has taken place in the *personnel* of the Dairy Bureau. Their annual report to the Legislature (House Document, No. 87), will be found printed on pages 219–234 of this volume.

Agricultural College.

The report of the examining committee of the Agricultural College will be found printed on pages 318–326 of this volume.

Returns of Societies.

These returns will be found printed on pages 273–302 of this volume. The summary is printed on page 303, contrasting the totals of 1892, 1893 and 1894.

Farmers' Institutes.

The societies held one hundred and twenty-five institutes in 1894. The places, dates and subjects will be found printed in the returns of the societies. A provision of law enables this office to furnish speakers for institutes. During the year 1894 this office furnished speakers for eighty-seven, at an expense of $1,084.98, an averege of $12.47. For 1893 the number was eighty-four, at an expense of $1,097.17, an average of $13.06. In November, 1894, a pamphlet was issued by this office, for the use of officers of societies and institute committees, containing the regulations of the Board of Agriculture concerning the holding of farmers' institutes by the several societies, with a list of available speakers and their subjects.

Scales of Points.

At the annual meeting in February, 1894, the Board *Voted*, "That the secretary be directed to communicate with the several societies, to ascertain how many score-cards they want at the contract price for State printing, in order that a sufficient supply may be obtained for the use of the several societies without expense to the Board of Agriculture."

In accordance with this vote the secretary caused to be printed 2,000 copies of each of the 15 sets of scales of points adopted by the Board in 1893, and 1,000 additional copies of the scale for fruits, at a total expense of $195.77 for the 31,000 copies printed. Thirty-one of the Massachusetts societies took scales in varying quantities. Scales were also furnished on request to several societies and individuals outside of the Commonwealth. The receipts for scales sold amounted to $122.46.

Agricultural Directory.

A directory of the agricultural organizations of the Commonwealth, with officers for 1895, has been prepared, and will be found printed on pages 341–355 of this volume.

Meetings of the Board.

The public winter meeting of the Board for lectures and discussions was held at Newburyport, Dec. 4, 5 and 6, 1894. The attendance was large and the meeting was in all respects a good one. The lectures and discussions will be found printed on pages 13–218 of this volume. A special business meeting of the Board was held at Newburyport, Dec.

4, 1894, an account of which will be found printed on pages 9–10. The annual meeting of the Board for the transaction of business was held at the office of the secretary, Feb. 5, 6 and 7, 1895, and the minutes thereof, reports adopted and essays read will be found printed on pages 307–338 of this volume.

CHANGES IN THE BOARD.

During the past year the following gentlemen retired from the Board because of the expiration of their terms of service: Wm. H. Bowker of the Worcester North-west Society, after six years of service; J. C. Newhall of the Franklin County Society, after six years of service; L. W. West of the Hampshire Society, after three years of service; John E. Kimball of the Oxford Society, after three years of service; Edward Warren of the Spencer Farmers' and Mechanics' Association, after three years of service; and G. C. Rowley of the Union Society, after three years of service.

CATTLE COMMISSIONERS.

Section 51 of chapter 491 of the Acts of 1894 provides that an abstract of the report of the Board of Cattle Commissioners to the Legislature shall be printed in the annual report of the State Board of Agriculture. The annual reports of the State Cattle Commission have been included in the annual reports of the secretary of the Board of Agriculture since the establishment of the commission, the first report appearing in the "Agriculture of Massachusetts" for 1860. There have been but two exceptions. For some unknown cause the report is missing from the annual volume for the years 1861 and 1883.

Heretofore the report of the commission has been a legislative document, and of small size. The report for 1894 is much larger, and has been made Public Document, No. 51. The report proper occupies 109 pages, and is subdivided into the following heads: general account of legislation and the work of the Board in 1894; work at Brighton, Somerville and Watertown; tuberculosis, prevalence, danger to public health, the tuberculin test and arguments pro and con, milk from tuberculous cows; glanders; laboratory; compensation for animals destroyed, history of the law of compensation in Massachusetts, arguments for and against compensation, laws of the several States on compensation, recommendations. Accompanying the report of the commissioners is an appendix containing the following: report of the Worcester Convention of the commission, the local inspectors and others; report of the Convention at the Department of Agriculture, Washington; the several orders, regulations and forms prescribed by the commission; and a tabulated list of all tuberculin tests, showing order issued thereon, and, if condemned, the post mortem.

A Resolve of the Legislature of 1895 provides for the printing of five thousand additional copies of the annual report of the Board of Cattle Commissioners, to be distributed by the State Board of Agriculture. It seems unwise, therefore, to include the entire report in this volume, and the pages devoted to the "laws of the several States on compensation" and to the "Appendix" are omitted.

WM. R. SESSIONS,
Secretary of the State Board of Agriculture.

BOSTON, March, 1895.

MEETINGS OF THE EXECUTIVE COMMITTEE

OF THE

BOARD OF AGRICULTURE.

1894.

MEETINGS OF THE EXECUTIVE COMMITTEE OF THE BOARD.

BOSTON, May 24, 1894.

The meeting was called in part to consider the request of the Blackstone Valley Agricultural Society for the approval of the Board to a mortgage of the property of the society authorized by vote of the members on May 11, 1894, said approval being necessary under chapter 274 of the Acts of 1890. A certified copy of the records of the meeting of the society, at which it voted unanimously to mortgage the property of the society for the sum of $1,300, was furnished the committee by the secretary of the society, Mr. Wm. L. Johnson. In accordance with the requirements of chapter 274, Acts of 1890, the executive committee duly advertised that a hearing would be given to interested parties; said advertisement appearing in the "Compendium," a newspaper published in Uxbridge, of the issue of May 18, 1894. No opposition to the contemplated action was manifested.

Voted, To approve the mortgage of the society's property to an amount not exceeding $1,300, and that the secretary be instructed to notify the society of this action.

Voted, That the rooms available for the use of the Board in the State House extension are not satisfactory.

Voted, That the matter be referred to a sub-committee, consisting of E. W. Wood, W. H. Bowker and Wm. R. Sessions, with instructions to ask the governor and council to assign rooms Nos. 154 and 155 (to be in the part of the old State House that is to be rebuilt) to the Board of Agriculture; and also to order the construction of a smaller room immediately south of said room No. 154 for a private office for the secretary of the Board of Agriculture; and also to cause the space in the rear of said room No. 154 to be finished into a storeroom and water-closet for the use of said Board.

Voted, That in the matter of scale of points for fruits it is impracticable to print cuts of fruits in time for the fall fairs, 1894.

Voted, That the matter be referred to a sub-committee, to consist of Messrs. Wood, Hartshorn and Sessions, with instructions to make arrangements for such cuts to be used next year, and that every member of the executive committee be expected to assist by furnishing specimens of fruits and measurements of good types of the several varieties.

Voted, That the matter of amendment of scales of points for 1894 be left to the sub-committee, consisting of Messrs. Wood, Hartshorn and Sessions, with power to decide upon amendments and additions.

Voted, That the credentials of Francis Shaw from the Massachusetts Society for Promoting Agriculture, and of Horatio G. Norton from the Martha's Vineyard Agricultural Society, be accepted, and their names placed upon the roll of members, and that these gentlemen be notified of the action of the Board.

Voted, In the matter of resignation of Francis H. Appleton from the gypsy moth committee, that the secretary be instructed to write Mr. Appleton in the name of the executive committee, earnestly requesting him to withdraw his resignation and continue to act with the committee for the remainder of the year, because —

1. The executive committee hesitates to take the responsibility of accepting the resignation of a member of the most important standing committee of the Board.

2. Because there is no member of the Board that can be appointed to fill the place who has had experience in gypsy moth work.

3. Because Mr. Appleton has been a member of the committee since the work was commenced by the Board of Agriculture, and has had such abundant experience in the work that he cannot be spared from it.

4. Because his influence as a member of the committee on the public at large and future legislatures will be much

more potent than that of any member of the Board who can be appointed to the place.

Adjourned.

BOSTON, July 26, 1894.

Voted, That the resignation of Francis H. Appleton from the committee on gypsy moth, insects and birds be accepted, inasmuch as he insists upon his resignation, and that the matter of filling the vacancy be referred to the Board of Agriculture.

Voted, That the secretary be authorized to expend as much as may be necessary of the amount remaining of the appropriation for collecting and circulating information regarding abandoned and partially abandoned farms in collecting information and printing and circulating another edition of the catalogue of such farms.

Voted, That the members of the Board of Agriculture be and are hereby requested to aid the secretary in collecting further information to be used in making up the forthcoming catalogue, to the end that said catalogue be as complete as possible.

Voted, That a sub-committee of three be appointed by the Chair, to request the proper authorities in the State government to forward the resolution concerning the extermination of the gypsy moth, adopted by the present Legislature (House on May 17, Senate in concurrence May 21, 1894) to our Senators and Representatives and to the secretary of agriculture at Washington; and to endeavor to secure a hearing upon the gypsy moth pest before a committee of Congress or of the department of agriculture if possible.

The Chair appointed Messrs. Appleton, Sessions and Bowker as the committee.

Adjourned.

SPECIAL MEETING

OF THE

BOARD OF AGRICULTURE,

AT

NEWBURYPORT.

DECEMBER 4, 1894.

SPECIAL MEETING OF THE BOARD OF AGRICULTURE AT NEWBURYPORT.

NEWBURYPORT, Mass., Dec. 4, 1894.

The Board of Agriculture met at Veteran Hall, Newburyport, this day at 9.30 A.M., for business.

Present: First Vice-Pres. James S. Grinnell, who presided, and Messrs. J. S. Appleton, Jr., Bancroft, Barton, Bursley, Clark, Clemence, Cook, Cruickshanks, Damon, Gove, Hartshorn, Harwood, Hersey, Horton, Kilbourn, Kimball, Lyman, Newhall, Pratt, Reed, Rowley, Sargent, Sessions, Francis Shaw, N. W. Shaw, Stetson, Ward, West and Wood.

The report of the committee on gypsy moth, insects and birds was read by the secretary and discussed.

Voted, That the report of the committee be accepted, and the recommendations thereof be adopted as the foundation of the report of the Board to the Legislature.

The commission to investigate the subject of the unemployed asked to be heard upon its work, especially as to the possibility of employment for those who are out of work upon the farms of the State. Professor Dewey, chairman of the commission, presented the matter, and asked for the opinions of the members of the Board of Agriculture. The matter was discussed by the Board, and the drift of the opinion expressed was that most of the unemployed preferred work in shops or service in the large towns and cities, and were unfamiliar with farm work; that they would not accept employment on farms except temporarily, and would leave at the first opportunity for employment in shop or city. The farmers could not afford to pay them satisfactory wages while learning to be useful, for they were liable to leave as soon as their services became of value. Such help also as a rule demand larger wages than they are capable of earning.

On motion of Mr. Hartshorn, the following resolution was unanimously adopted: —

Resolved, That the Massachusetts State Board of Agriculture hereby endorses the bill now before Congress, placing oleomargarine under the provisions of the laws of the several States (the bill introduced in the Senate by Senator Hill of New York and in the House of Representatives by Representative Apsley of Massachusetts), and requests the Massachusetts Senators and Representatives to use all proper means to secure its passage.

Voted, That the secretary be instructed to send a copy of the resolution and the action of the Board to each of the Senators and Representatives in Congress from this State.

Mr. Geo. M. Whitaker, assistant executive officer of the Dairy Bureau, gave verbally the substance of what the report of the Bureau to the Legislature would contain, and the recommendations that would be made.

Voted, That the report of the Dairy Bureau as outlined be approved by the Board of Agriculture.

The meeting was then formally adjourned.

PUBLIC WINTER MEETING

OF THE

BOARD OF AGRICULTURE,

AT

NEWBURYPORT.

DECEMBER 4, 5 AND 6, 1894.

PUBLIC WINTER MEETING OF THE BOARD,

AT NEWBURYPORT.

The annual public winter meeting of the Board was held in Veteran Hall, Newburyport, beginning on Tuesday, December 4, and continuing through the two following days. The meetings were well attended by members of the Board and by the people of Newburyport and vicinity.

The meeting was called to order at 1.30 P.M. by the first vice-president, Hon. JAMES S. GRINNELL of Greenfield, who stated that Mr. F. W. SARGENT of Amesbury would preside at the opening session. Mr. Sargent then took the chair and said: —

The CHAIRMAN. Ladies and gentlemen, it gives me great pleasure to stand before you to introduce to you the speakers of the day. I will open the exercises of the afternoon by introducing the mayor of Newburyport, who will welcome you to this city.

ADDRESS OF WELCOME.

BY HON. ORRIN J. GURNEY, MAYOR OF NEWBURYPORT.

Mr. Chairman and gentlemen of the State Board of Agriculture: Since occupying my present official position I have often wondered if the mayors of other cities find as much difficulty as I do in knowing what to say when called upon to extend a welcome to the different organizations visiting their cities. These organizations are of such a varied character, comprising, as they do, military, social, industrial, agricultural, charitable and religious organizations, that I am always at a loss to know just what remarks will be appropriate for the occasion. But, Mr. Chairman, a true welcome does not consist so much in the making of an eloquent speech, as it does in the heartiness and sincerity of the welcome extended; and I am proud, sir, to be able to say that Newburyport is second to no other place in this respect. Wherever known, which is throughout the world, she is noted for her hospitality, her latchstring is always out, and her citizens are not only glad, but they esteem it a privilege, to open their doors and their hearts whenever visitors from abroad enter her borders. While we may not be able to entertain upon such an elaborate scale as many larger and wealthier places, we always do the best we can, and do that cheerfully; and it gives me great pleasure, to-day, to be permitted in behalf of the people of Newburyport to welcome to our city the Massachusetts State Board of Agriculture.

It gives me pleasure for two reasons: First, His Excellency the Governor is the president ex-officio of your Board, and we always take delight in honoring the Governor of the Commonwealth; and we take special interest in the present Governor, for when visiting our city prior to his first election he made many friends among our citizens, so that when he came before them asking for their votes we gave him a good majority, which we greatly increased at the last election, and which, I believe, will assume larger proportions in the fall of 1895. It gives me pleasure in the second place to welcome your Board, because you are the representatives of the class on whom, more than any other, our country is dependent for its prosperity, — the farmers, the tillers of the soil, those who provide us with our flour and grain, with our vegetables and meat, and without whom we could not well exist. When the crops are abundant and the farmers are prospering, all classes, the manufacturers, the merchants, the mechanics and the laborers, reap the benefit of their prosperity. When the crops are poor and the farmers are not prospering, the whole country suffers accordingly. We have heard a great deal about protection for various manufacturing industries, while the farmers, who should be protected above all others, are almost, if not quite, forgotten. While the wealthy capitalist transfers his riches into government bonds and other like securities, locking them up in safety deposit vaults, thereby escaping the assessors' doom, the farmer's little wealth, consisting, as it does, of his land, his buildings and his stock, is all spread out before the eye of the assessor, and, as a general rule, the farmer's property is taxed for its full market value. The farmers are also the most independent people, enjoying greater freedom than any other class; and it seems strange to me that so many people still herd together in the crowded tenements of the cities, eking out a scanty existence, when, with a little energy, they might go out into the country, where, breathing the pure air of heaven, they can enjoy nature in all its beauty, and, where, if they are industrious, they can be assured of a comfortable living.

Much more might be said in favor of the farmers and the farmer's life, but I take it for granted, Mr. Chairman, that I am not expected to make any extended remarks at this time. Therefore I will close by bidding you all a hearty welcome, and extending to you the freedom of our city, with the hope that your present visit may prove such an enjoyable one that you will all be as glad to visit us again, as I assure you we shall be to receive you.

The CHAIRMAN. In response to this hearty and cordial welcome, it now gives me great pleasure to introduce the honorable secretary of the Board of Agriculture, WILLIAM R. SESSIONS.

Secretary SESSIONS. Mr. Chairman, gentlemen of the Board of Agriculture, and citizens of Newburyport and vicinity: This is a pleasurable duty, although the circumstances which have placed it upon me are of the contrary character. You notice by the programme that it was expected our honored second vice-president, who is also president of the Essex Agricultural Society, would have performed this pleasant duty of replying to the address of welcome. I am informed by him of his great regret in being deprived of the privilege of thus appearing before you, and am obliged to say to you from him that in all probability he will be debarred from attending any of the sessions of this meeting, to which he had looked forward with so much pleasure.

For the Board of Agriculture, I can say in response to your welcome, Mr. Mayor, that we are happy to come to old Essex. All of us have known something about her in the agricultural prints of days past, and in the secular papers. We have known of her history and her brilliant record in the colonial days, in the days of the revolution, her triumphs of commerce in later days, and her triumphs in manufacture in still later days. The wealth of old Essex in her children is something that the whole country may be proud of. I need not enumerate names.

You understand, of course, that this duty has come upon me unexpectedly, and without opportunity of preparation upon my part, and as our friend Mr. Appleton has very kindly written a letter which he desired me to read to you in place of his address, I will allow that to take the place of any further remarks which I might under other circumstances be constrained to make: —

Dec. 3, 1894.

Hon. Wm. R. Sessions, *Secretary State Board of Agriculture.*

Dear Mr. Sessions: — It is with sincere feelings of regret at both the cause and the fact, that I am compelled to be absent from the Newburyport meeting of the Board, in my own county of Essex, for which I have so much interest and affection.

But one who has been very near to me in family ties has been taken away, — an Essex County man also, by birth and education, brave and sincere in his business work, and who leaves my widowed mother behind him.

You will all pardon these references at this time, since, on reflection, I recall in the man whom *she* called father and I called grandfather, a Salem man, an Essex County man and a true citizen, who, like the early brave merchantmen and pioneer mariners of the good city of Newburyport, crossed the broad ocean from Salem harbor with cargoes of goods, as the basis of several trades abroad, before a return brought profits, which helped to build up industrial plants in, and otherwise develop, our country.

Such a man was that father and grandfather, Nathaniel Silsbee, who was to me when I was a little boy, very dear, and whose love for his country and State endeared him to his constituents, as is proved by their show of confidence in him. He was from 1816 to 1820 our Congressman; for 1821 and 1822 State Representative from his home town; 1823–25 president of the State Senate; and from 1826 to 1835 United States Senator and a colleague with that able statesman, Daniel Webster. In 1840 he was a delegate to nominate a presidential candidate.

He was earnest for everything that would promote profitable industries for our people, and advance the prosperity of Massachusetts and Essex County; he was loyal and sincere to his public trusts; and I know my fellow members of the Board of Agriculture will excuse my absence and pardon me for reference to this worthy type of Essex County manhood.

Please say to His Honor the Mayor, that I regret to lose the opportunity of replying to his words of welcome, and let me express to him the appreciation, which must be felt by all our Board in the interest taken by the Newburyport Board of Trade and the farmers' clubs, granges and individuals in this neighborhood, in preparing for this winter meeting.

I had hoped to personally join with the mayor in welcoming, in behalf of our old Essex Agricultural Society, the State Board of Agriculture, the lecturers and visitors to this meeting, whose object is to strive to aid and advance the agriculture of old Essex by now coming into her territory.

I have been interested in looking up the comparative standing of Essex County agriculture, in the midst of which you now meet. I find she stands as the third county in the State as to "persons assessed," with 115,520; third in "assessed valuation," with $241,464,050; third in number of horses, with 21,423; third in number of dwelling-houses, with 53,033; fourth in number of swine, with 3,070; seventh in number of neat cattle, with 18,712; tenth in number of sheep, with 450.

I regret that we have no figures to show the great quantity of produce that is yielded by our lands to supply our markets; nor can I tell you by figures the great falling off in the sale of farm produce in consequence of the depressed condition of business, and the decreased amount of means in the hands of all individuals towards the purchase of those health-producing, and life-prolonging products of the farm and garden.

How closely allied are the producer and the consumer in their respective interests; and so closely should both producer and consumer be brought in our land, that they may be found shoulder to shoulder at all times to promote the greatest degree of prosperity to all our business.

But I want especially to call attention to a special feature, which seems to me of great importance to-day, and which is a part of the work allotted to our Board; and that is, the careful regard for the improvement of our live stock, which I have shown exists to so large an extent in the county where you meet.

I regard its *average* condition much below the standard that it might and should attain. We must not be satisfied with high records from marked individuals; such are most praiseworthy and to be encouraged, but mislead as to the true average of quality.

If a person will stand for a short time in a fixed spot on the sidewalk in a crowded city, and note the uneconomical quality of most of the horses that pass, for the work which they are performing; or go to a milk farm, where many cows are kept, and learn the small average of quarts per day from each cow for the year, and also listen to the regrets of the owner that he cannot find cows at any market where he is a purchaser, of a better average standard, — he will be impressed with the fact that the quality is much inferior to the possibility, and our needs.

Good pigs of the best quality to fatten are too often difficult to find.

What can be done to promote a higher quality in our useful animals seems to me a serious question to be considered. Would the example set at the great fair in Chicago, of having selected herds of the various breeds of neat cattle and other animals exhibited in different parts of the State, at times when our farmers could most readily visit them, be helpful as object lessons for New England? Would the State have to be financially behind such an effort, in order to insure success?

But I have written, perhaps too much, and, with regrets that I probably cannot be with you during the week,

Believe me, in mutual interest for agricultural advancement,

Yours very truly,

FRANCIS H. APPLETON,
of the Board of Agriculture.

The CHAIRMAN. As a farmer of Massachusetts, and of Essex County in particular, I would say a word in regard to the interest which we have all taken in the work being done by the agricultural colleges of this vicinity. We all have an honest pride in the work of our own Massachusetts college. We follow out the doings of that college by the bulletins and by the reports as they are issued, and learn in regard to our business from the work which has been done there. Within the last few years we have had the agricultural college of New Hampshire located very near the border of Massachusetts, and we have taken a great interest in the work that is being done there. It has been seen fit by the committee of arrangements to call upon the president of that college to speak here this afternoon. His subject is "Industrial Education," and I now take pleasure in introducing to you Dr. C. S. MURKLAND of Durham, N. H.

INDUSTRIAL EDUCATION.

BY DR. C. S. MURKLAND, PRESIDENT, NEW HAMPSHIRE COLLEGE OF AGRICULTURE AND THE MECHANIC ARTS.

Mr. Chairman, members of the Massachusetts Board of Agriculture, and friends: It is with great pleasure that I am permitted to speak here to-day. It occurred to me while your chairman was speaking that undoubtedly one of the reasons why the New Hampshire college was moved nearer to your border was because of the strong attractive tendency of the State of Massachusetts, naturally drawing us by its educational energy; and I am very sure that all we in New Hampshire who are interested in education are delighted to get nearer Massachusetts, either locally, or in spirit, in purpose and in method.

The necessity of condensing what I might wish to say in the time allotted me has compelled me to leave some important matters utterly unmentioned, and to briefly touch upon others, simply commenting upon a few points; for the subject of industrial education is not one which can be disposed of in a few words, — it is a subject which touches vitally the interests of our people. Without further introduction let me say: —

It is the misfortune of educational movements that they have always to deal not only with the resistance of ultra-conservatism but also with the impatience of impetuous radicalism. On the one hand is the drag of objection, on the score that that which has been good enough before is good enough now; and on the other hand is the strain of insistance upon perfection, as if educational methods and results might spring forth fully developed, as Minerva was said to spring fully equipped from the head of Jove. One class of people clamors against anything largely new in educational methods and purposes; while another class clamors, with equal vehemence, for such development of the newer methods and such definition of the newer purposes as have been gained for the older education only by the experience of centuries. To clearly understand this double strain is to get at the heart of the difficulties in the way of industrial education; and to get at the heart of the difficulty is at the same time to gain an understanding of the position of industrial education, in this country as in other lands.

Industrial education, which may be defined as education having in view immediate application in some of the pursuits and professions of life, is at present involved in some necessary confusion in this country, because of the difficulties it has met on either hand. It was inevitable that so great an innovation as that embodied in the changes from the traditional and time-honored methods of education should, for its definite development, require much more time than has yet elapsed since the first institution for industrial training was established. An expression used by Dr. William T. Harris, the United States commissioner of education, in a recent address, will be found useful in making this fact clear. In that address * he spoke of a "pedagogical form" as a necessity in teaching any subject. And by the phrase "pedagogical form" is meant a series of lessons so arranged that they shall be actually progressive. In mathematics, to use the illustration Dr. Harris himself used, there is a definite progression in which each lesson plainly follows the lesson before it, and demands that the preceding lesson shall have been mastered. In mathematics and the classics the "pedagogical form" has been developed by long trial, and is essentially fixed. There may be changes in text-books; it may be questioned whether or not Cæsar shall follow the lessons in easy Latin, the fables and short historical extracts; but the teaching form is not thereby affected. One who has to teach mathematics has no difficulty in deciding which place in the course shall be held by analytical geometry, for instance. He has only to decide what text-book will best suit his classes by being best adapted to the requirements of

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* Before the American Association of Agricultural Colleges and Experiment Stations, Washington, D. C., Nov. 14, 1894.

the pedagogical form under the circumstances in which he finds those classes. The same is true of him who has to teach the classics, or even the modern languages. In the matter of language the form is less definitely determined than in the case of mathematics, but it is still fairly well defined. It certainly is to be questioned whether or not there has been any improvement upon the system which simply took the "pedagogical form" used in teaching the classics and applied it to teaching the modern languages. The main fact, however, is clear; in the older education, represented by the teaching in the classical colleges, there has been the advantage derived from established forms, by which both the process and the result of the teaching have been essentially fixed.

Industrial education, on the other hand, has lacked this advantage; and, lacking this, it has lacked that which can be gained only through the experience of many years, and by the tentative trials of many institutions during these years. Industrial education in this country, as in Europe, is too young to have arrived at the maturity which will represent what such education is when at its best. And this which is true of industrial education in general is true of its different divisions. So that it is a thing to be expected that those departments of industrial education which lend themselves most readily to a teaching form should be most perfectly developed and therefore in the most satisfactory condition.

Mr. Carroll D. Wright, commissioner of labor, presented a report, Feb. 7, 1893, in which he adopted a classification separating industrial education into three divisions, respectively represented by the schools for manual training, the technical schools and the institutes of technology. The "half-developed colleges of agriculture and the mechanics," as he calls them, he places between the technical or trade schools and the technological institutes of university grade, giving them, rightly enough, perhaps, an indefinite and rather nondescript position. Adopting, for convenience, his classification, it is to be noticed, first, that industrial education has been concerned with the mechanic arts and the manufacturing industries almost exclusively, until a very recent date. From the establishing of the Rensselaer Institute, at Troy, New York, in 1842, till to-day, engineering, in some of its divisions, has been the predominant department in the industrial institutions in the United States. Allied with mathematics as engineering always is, demanding a thorough preparation in mathematic instruction as it does, this department of industrial education has easily adopted the pedagogical form ready to its hand in the established form of mathematical teaching. In affording new details of application, engineering has not had to grapple with the difficulty of supplying or developing the form itself; it has found the form already prepared for its use.

This is something which should never be forgotten by those who are moved to speak or write upon this subject. It is easy enough, for instance, to complain that in the industrial or technical institutions of the country agriculture is overshadowed by mechanics. It ought to be easy to see that while this may be the case, while it is naturally, even necessarily, the case, it is so simply as a temporary phase of the general problem of industrial education. It is not that one department is held in higher regard than another. It is simply that one department found a teaching form ready to its use, while another faced, and faces still, the necessity of developing its own form. No one has advanced a form for teaching agriculture, for instance, so definite, so well arranged in progressive sequence, that it could be generally adopted as, on the whole, a satisfactory method for universal use. It may be safely prophesied that no one will suggest such a form for some years to come. And the institutions in which agriculture is taught are thrown thereby into a confusion which is for the present practically inextricable. What requirements shall be demanded of the students who enter such institutions? How shall the studies apportioned to the successive years be determined? How long shall the prescribed course be? What degree shall be conferred upon completion of the course? These are questions which find answers as many as there are institutions involved. And this confusion cannot be reduced to order until it is possible to apply to every department in such institutions some well-defined form of teaching, such that the progress in one department shall be as definite and as real as the allied progress in every other department.

I have singled out the department of agriculture for illustration for two reasons: first, because I assume that a session of the Massachusetts Board of Agriculture is interested chiefly in teaching agriculture; and, secondly, because the department of agriculture in our institutions of industrial education is the department which suffers most from the lack of definite form in teaching. The same considerations lead me, at this point, to dwell upon the relation between agriculture and other departments of industrial education.

We have always to consider the end to be attained in education. Few parents would be satisfied if their sons were to receive from the institution they attend nothing but the training which would prepare them for the mere drudgery of the occupation they choose. Wood-working and iron-working are included in the mechanical courses not simply that the students may be fitted to be carpenters and machinists; students must master preliminary details for the sake of larger constructive operations. A boy may learn the carpenter's trade by an apprenticeship of three years, and be paid for his work all the time. It would hardly pay him to go to a technical school for four years, meeting the necessary expenses out of his own pocket or out of the treasury of the State or the nation, only to gain such skill as he might be paid for acquiring in less time. A simple trade school, which attempts nothing but to produce skilled artisans, can justify its being only by turning out better workmen than the shop can turn out, or by reducing the time of apprenticeship, or by adding something which an apprentice would not learn. As a matter of fact, the technical schools of the lower grade do not attempt to reduce the term of apprenticeship, requiring, as they commonly do, more than three years' time. Nor do they, as a rule, claim to produce better artisans. A journeyman carpenter will not have spent over the construction of perfect joints so much time as the graduate of a trade school, but he will have gained much more in deftness and quick facility in the use of tools. On the whole, the journeyman carpenter who has served his apprenticeship will be a better carpenter, for general work, than the school graduate. It is not by giving the same instruction in a shorter time, nor yet in giving better instruction covering the same ground, that a technical school must show its superiority to the school of apprenticeship; but it is in adding to the mere technical training such other instruction as shall better equip the learner for his place among men. Industrial education must be more than learning and teaching trades; more, even, than adding to the development of technical skill a certain ability to apply general principles to the details of a handicraft. It must fit the learner for life, — for the life a man must lead among men; and that is something more than the life a carpenter must lead among carpenters, or a machinist among machinists, or a farmer among farmers. This is vital in any consideration of the nature, the purposes or the methods of industrial education. And until we have found how the technical institution may best fit its students for the large relations which they must sustain, always having in view the special vocation and also the general human obligations, we shall not have solved the problem of industrial education.

This has its immediate bearing upon the relation between agriculture and other departments of industrial education, and in this way; with such material for teaching as is now available, there is no perspective possible in teaching agriculture. Arranging different courses of study in a general agricultural course is as nearly hap-hazard a process as anything can be in matters of instruction. Coming fresh from a convention of the so-called agricultural colleges of the country, I am sure of my ground when I say that this is a common fact in the experience of these institutions. Certain text-books may be assigned to the senior year in one of these colleges, with absolutely no reason why they should not have been assigned to the freshman year, or, for that matter, to some year of the preparatory school course. Where there is any perspective, it is afforded by the dependence of agriculture upon some more definitely formulated scientific study, as in the cases where an understanding of elementary chemistry is involved. In other words, teaching agriculture gains the perspective of a pedagogical form only when it adopts the form determined by some more precisely formulated science; and where no such other science is involved, there is nothing of that orderly sequence in the progress of the instruction which has made the classical education, and in some degree the scientific education, a process commanding respect by the intellectual development it inevitably implies.

I am anxious to make this clear, even at the risk of some repetition. Here are sixty so-called agricultural colleges, or thereabout, each attempting to give as complete instruction in agriculture as is possible. And I suppose every one of them has to withstand the diverse strains of which I spoke at the outset. On the one hand the inertia of the sentiment which sneers at scientific farming; and on the other hand the strain of the foolish impatience of those who cannot understand that until agriculture is reduced to a science it cannot be taught as a science. Reduced to a science agriculture certainly has not been. It involves some smattering of scientific knowledge; mainly, as has been indicated, of elementary chemistry. But that farmers are able to speak of potash, and phosphoric acid, and nitrogen, and albuminoids, and carbohydrates, hopeful as this is as a promise for the future, is not a demonstration that agriculture itself is even approximating to the exactness of a natural science. It has hardly attempted to use the scientific method of careful and exact observation of facts with reference to large generalizations. How could it be otherwise? What inducement has there been for men to regard their farming in the light of a scientific possibility? The patient, painstaking accuracy, the willingness to wait long for apparently meagre results, the disregard of immediate financial return, — such qualities as these, all factors of the scientific spirit, have had little opportunity to exercise themselves in the details of tilling the soil. The wisdom of the national government in establishing experiment stations has begun to afford such an opportunity, but only the veriest beginning can have been made in seven years. And the agriculturists themselves have hardly, as yet, been willing to unite with these stations in carrying out the work which demands such general coöperation. Until there is a science of agriculture, as there shall be some day, there cannot be any satisfactory teaching of agriculture worthy of a college name or a collegiate degree. And the agricultural colleges may face the facts.

Again, if there were a well-defined science of agriculture, it would not in itself constitute a complete industrial education. We might, even now, do what some of the frequent contributors to the agricultural papers seem to demand, and give instruction beginning, say, with the method of cutting and carrying wood for the kitchen fire. Then we might proceed to show how to handle a shovel, a spade, a two-tined fork and a four-tined one, and so on. But it is hardly probable that boys would go to a college, or whatever the institution might be called, to learn that which they are not too willing to practise at home, where they have, at least, board and washing and clothes furnished them. As in the case with trade schools, the agricultural college can justify its being, not by giving the training which might have been given on the home farm, nor yet by compressing that same training into fewer years, but by adding to it something which shall tend to make the student a better farmer, a better man and a better citizen on his farm. It was profound wisdom which united the mechanic arts with agriculture in the fundamental law establishing the various colleges. Where there are institutions designed to be exclusively agricultural, as in Massachusetts, the same advantage is gained by broadening the course of study so that it shall embrace many branches which are general rather than technical. These studies benefit the agricultural course from the fact that they are not themselves agricultural. They make it possible for the student to gain that personal development which makes for general fitness rather than for special aptitude. And they also ally the more specifically agricultural studies with other studies which have a teaching form already fixed. It would be no benefit to agriculture if we could succeed in forcing an institution to cut out everything in its curriculum which is not directly and immediately technical. No more deadly blow could be struck at the agriculture of the future than would be struck if such a movement should be made universal or even general. Technical education as applied to agriculture is incomplete so far as it is exclusive; it needs, as other branches of technical education do not in the same degree, the help of other studies technical or general. For, lacking the form of progressive sequence, it lacks the first educational requirement. It will not insure the general development of the pupil, nor will it even fit him for the profession of agriculture.

It may seem as if I had conceded too much in granting, as I have, that technical education as applied to agriculture is confused, immature, and not upon a level with other departments of technical education. But there is some hope in it. For there is nothing in the method of instruction in agriculture to prevent such reconstruction, or such gradual improvement, as may be suggested by longer experience. The name "agricultural college" is, I suppose, a designation which is likely to be permanent. But the agricultural colleges will never command the respect which other colleges command until they earn it. No decree, no legislation, certainly no declamation, will elevate the institution which is not exalted by its own worth. One of two things, and probably both of them, our agricultural colleges must do, if they are not always to be considered, as many people now consider them, institutions where a partial education may be gained, an education distinctly lower, upon the whole, than that of the classical college. Either the agricultural college must produce men who are far on the road to eminence in their chosen specialty, or it must produce men able to maintain their places side by side with the bachelors of arts from other colleges. If the institution aims to produce eminent specialists, and only these, its constituency will be reduced to narrow limits; if it aims to send forth specialists, and at the same time to give as complete general development as any institution can give in the same time, there is no reason why the agricultural college may not have a constituency practically unlimited, and win for its name genuine honor. So long as either agricultural or technical education is of greatest interest to us, we ought not to rest until the agricultural college is recognized as the equal of any college in the land.

There may be some points of detail which should not be entirely overlooked. For many questions rise, questions which must be answered somewhere, and which may not unfittingly be asked here. At what point shall the technical education, specifically that pertaining to agriculture, begin?

What shall be accepted as sufficient for admission to the technical college, the college of agriculture, for instance? How long shall the course be? What kind of testimonial, or degree, shall be conferred at the end of the course? These are living questions, and will not soon be finally answered. But some suggestions, with principles back of them, may be made.

Naturally, one begins with the last, for the end determines the beginning, as truly as the beginning conditions the end. And, in the first place, there should be no degree, representing four years of college residence, which can be regarded as of less worth, less honorable, than any other degree representing the same expenditure of time. If at the end of four years spent in one college there is a bachelor's degree conferred, making the bachelor of arts a person of rightful distinction, the agricultural college ought not to confer a degree which may be considered as less honorable, as is the degree of bachelor of science. I think I hazard nothing in saying that the letters B.S. attached to a graduate's name do not carry so much weight as the letters B.A., and that is not so very much. This whole matter could be greatly simplified, and would be, if it were a settled principle that the degree of A.B. means that the one receiving it has, after a definite preparation, satisfactorily completed a four years' course of study in an institution of collegiate grade, — it does not matter what the course, scientific, technical or classical. This suggestion is not new, nor is it original with me. But I am convinced that it is correct in principle, and that if it should be applied to the so-called agricultural colleges it would be to the general benefit of industrial education, perhaps of all education.

But this assumes that the institution is of collegiate grade; and the grade of an institution is largely determined by the requirements of admission to it. We cannot admit students with poor preparation or with no preparation at all, and with such material maintain a standard of scholarship worthy of the collegiate name. The question of the degree, thus, involves the question as to the length of the course and the question as to the requirements for admission. As to length of the course, it should not be less than four years, unless a shorter time, three years, for instance, be accepted in other institutions conferring the same degree and having the same requirements for admission. President Eliot suggests that three years ought to be enough; but this is entirely a question as to the starting-point. With a preparation covering a year's work more than is covered commonly by applicants for admission, the college course might be reduced to three years' time; but with preparation under the ordinary standards of Massachusetts, New Hampshire and the other States of New England, it will take four years to produce the development of mind without which there ought to be no degree conferred, of A.B. or B.S. This does not mean, necessarily, that there must not be shorter courses, requiring less and giving less. But the degree should be the same for equivalent attainment in all institutions. In the department of agriculture, it may be possible that a course of two years would appeal to many young men to whom a course of four years would seem like an impossibility. On the other hand, however, is the danger that a course of but two years, with a certificate, of course, not a degree, at the end of it, would tend to lower the standard of the institution, and thus indirectly defraud every graduate who has pursued the full course and thus become entitled to standing as a bachelor of arts. A short course in agriculture is an acknowledgment of the truth of which I have spoken, — that in teaching agriculture there is no determined form of progressive sequence. It may also be a confession that the graduate in agriculture is not to be considered equal with the graduate in other departments. So far as this is the meaning of it, the short course is to be unqualifiedly condemned. In any case the question of preliminary requirements is involved. For the candidate for the short course is almost inevitably one who is not prepared for the full course; one, in other words, who belongs in a preparatory school, not in a college. The degree of A.B. should be given, after satisfactory completion of the determined number of years' work, but with a definite preparation assumed in every case. What should the preparation be?

This is the practical difficulty in the way of industrial education. And it is to the honor of the Massachusetts Agricultural College that it is seeking to confer the greatest benefit upon its students, and thus to advance industrial education, by raising its standard and increasing the requirements for admission.

I wonder if you understand how much of the heroic there was in such action when President Goodell, together with the faculty and the trustees of that college, consented to raise the standard, at the risk of decreasing the numbers. It was a brave, honorable, manly thing for them to do; and honor will be done them for it as surely as truth is truth, as surely as God gives the final mastery to that which is right and perfect.

Three things ought to be demanded of every candidate for collegiate standing: a thorough preparatory training in mathematics, up to the point now commonly fixed upon by our colleges; a thorough training in English. (I wish I might show some of the English that we get, or at least some of the things that are supposed to be English, but are not. How can you give a college training, building up the vast superstructure, with no foundation? We ought to demand of our public schools more and more insistently that they allow no boy, no girl, to go out from their doors without understanding something of the use, the power and the beauty of his native tongue. There is danger of giving overmuch attention to scientific training. We are carrying that too far, — not teaching too much science, but too many sciences. There is a vast distinction between the two things. Instead of developing in our students the scientific spirit, I think we have tried to cram them with facts.) There should be, I say, a thorough training in English, including a course extending over not less than two years; a touch of scientific teaching, enough to make the student familiar with the scientific spirit and method; and a thorough discipline in some language which has a fixed pedagogical form, preferably Latin. The technical institution may not have Latin in its course; that is not at all to the point. The study of one language which can be progressively taught is of peculiar educational value, even if the student does not expect ever to use the language itself. German would serve almost as well as Latin, French almost as well as German.

Greek lacks the incidental practical value of Latin, German and French. But one language other than the English should be required, as a guarantee of the preliminary fitness required by the collegiate standard. There should be at least three years of solid study, grinding drill, until the student has learned something of the formation of language, and much of its use.

I know there are some who have the feeling that we can somehow absorb language by talking a good deal, writing a little and reading less, and doing all with no particular care and application of the mind to the work. We shall not get a final agreement as to all this in one year or in ten years, but we have our eyes fixed on the future, "and wisdom is justified of her children."

There are matters of detail which must not be dwelt upon here. What I have said, in this hasty and inadequate treatment of the theme of "Industrial Education," I have said because there is so large an opportunity for the Board of Agriculture to further the cause of education, and, most of all, agricultural education. Indeed, to hold official position of any kind in the grand old Commonwealth of Massachusetts is to be under a certain educational compulsion. As representatives of the farmers you are empowered to act in both directions; upon the resistance of those who would oppose every movement towards a scientific agriculture and a scientific teaching of agriculture; and upon the impatience of those for whom the car of progress moves too slowly. Little by little the great problems of industrial education, problems not fairly appreciated until yesterday, are being worked out. And with the co-operation of the agriculturists themselves, with such unanimity as is possible when institutions and people together seek for the common good of all, the agricultural colleges will go on to definite aims, to wise and comprehensive methods, and to such general development as shall make the name agricultural college a true designation, and also a title of honor.

I thank you, Mr. Chairman and gentlemen, for your courtesy. There are a thousand things I would be glad to have said. I am not sure there is anything that I have said which I would wish unsaid. The cause of truth is ours. Science and industry are God's handmaids, as they are truth's. By them we shall gain the consummation of human life.

The CHAIRMAN. The subject of salt marshes and salt hay is one which is to be taken up at this time. I am aware that it is a subject that may not interest some of the farmers from the western part of the State, but it is one of great importance to farmers here on the coast, where more than three thousand acres of salt meadow are used for the spontaneous growth which they produce, and which we are learning to harvest in an improved manner. I hope that we may receive much greater benefit from these marshes than we have in the past in the old way of harvesting the hay. The gentleman who is to talk upon this subject has done some very good work in the way of preparing formulas for feeding dairy stock; and he has also done some very good work in making analyses, and giving information in regard to this crop. I hope that he may interest you all in this subject, although, as I said before, it is one that may not be of importance to many of the farmers who are present from a distance. It gives me pleasure to introduce Prof. G. H. WHITCHER of Durham, N. H.

SALT MARSH HAY.

BY PROF. G. H. WHITCHER, DURHAM, N. H.

I shall ask you this afternoon to follow me along three principal lines of thought: —

First. — Upon what does rational stock feeding depend?

Second. — How is the practical farmer to make use of the information already accumulated?

Third. — What system of farming is the best adapted to those farms that include a portion of the great belt of salt marsh?

UPON WHAT DOES RATIONAL STOCK FEEDING DEPEND?

Every farmer would like to do his work in the best manner possible. He would like to be possessed of the knowledge that should enable him to raise perfect crops, produce perfect fruit, make perfect butter, raise perfect horses, cattle, swine and poultry, and feed perfect rations to his stock; and it is in the effort to approach this perfection that progress is made.

Perfect feeding consists in supplying any given animal with the greatest amount of food of the best possible combination that can *with profit* be consumed. This is an easy thing to say, but it is a difficult thing to do. The preaching is easy but the practice is hard, and in its accomplishment three great factors must be considered: —

First. — How much food does the animal require?

Second. — How can we combine foods and supply this required amount?

Third. — How can we adjust the *cost of the food and the value of the product* in the most profitable relation to each other?

Every animal has a limit beyond which profitable feeding may not be carried; and, while this limit varies in different individuals, yet we must content ourselves with averages in dealing with the principles, and must leave it to the intelligence of the feeder to discover the variation from the general rule.

It has been quite well established in the mechanical world, that certain amounts of certain kinds of coal under boilers of known efficiency will develop a horse-power; and these results, chiefly obtained experimentally, are figured upon with a good degree of certainty in estimating the cost of a given product. In much the same way has it been found that certain amounts of food are required in producing given results under average conditions; and we are able to predict with some degree of confidence what results will follow from certain rations, as compared with others of different character.

But to establish the quantity of food required involves a knowledge of what food is, and this brings us to the subject of the chemical composition of fodders. There are certain substances found in all feeding stuffs, but the quantity or per cent varies greatly. Starch is always found, but it may be present in small quantity, as in cotton-seed meal (less than six per cent), or as in cornmeal, constituting three-quarters of the weight. Sugar is always found, and oil, fibre, water and albuminoids. The chemist is able to tell us the composition of any of our foods; and as an object lesson I have in these two series of bottles the chemical constituents of a pound of cornmeal and a pound of cotton-seed meal. I have taken these two foods because they are very common ones, and because they represent two distinct general classes of food. You will see that the cornmeal has a very large amount of starch, while the cotton-seed has very little; of the albuminoids the cornmeal has but little, while the cotton-seed has a large amount. Here, then, is the great distinction between the foods. One is starchy, the other is nitrogenous or albuminous; and we may class the bulk of our fodders and grains under one or the other of these heads; and, as will be seen later, this classification is of great importance in making up rations.

But there is another fact to be considered, namely the digestibility of fodders. Not all of the hay and grain that enters the stomach is food; a portion passes unchanged from the mow and bin to the manure pile, and is no more food than the rock and shale found in our coal is fuel. It is only that part of the fodder that is made soluble in the process of digestion that is food in the true sense of that word; hence we have the results of thousands of experiments designed to determine the digestibility of the long list of fodder articles.

I have said that food may be classed under two heads: nitrogenous (having a large amount of albuminoids), and non-nitrogenous or starchy. This is possible because it has been found that digestible starch, sugar, fibre and oil are put to the same use in the animal system, and it is a matter of indifference whether we feed a pound of sugar or a pound of starch; oil, while the same in kind, is more effective pound for pound, and scientists rate a pound of oil equal to from one and three-fourths to two and one-half pounds of starch; so that in all subsequent use of the chemical composition of food I shall speak of digestible albuminoids and digestible non-albuminoids, including under the latter starch, sugar, fibre and oil, the oil being multiplied by two and one-half, to bring it up to its equivalent in starch.

Uses of Food.

The animal consumes food to sustain life, we say; but by this we mean that there are three great uses for food in the animal body: to maintain the bodily temperature at 100°; to supply the energy which shall enable the animal to move from place to place or draw loads or exert itself in any way; and, last, to produce growth, whether of new tissues to replace worn-out ones, or to give increased bodily weight, or to produce milk, meat, eggs, etc.

Returning now to a consideration of *what the animal requires*, and we have the results of the German scientists, who, after first experimentally determining the ration or rations that in *practice* produced the best results, next determined how much actual food, that is, digestible matter, these rations contained; and they found under these conditions that for a cow weighing one thousand pounds, and giving milk, there must be provided daily an amount of food that should supply two and one-half pounds of digestible *albuminoids* and thirteen and one-half pounds of digestible *non-albuminoids;* and this is the German feeding standard, having a *nutritive ratio* of 1 : 5½ ; or, in other words, a cow requires five and one-half pounds of non-albuminoids for every pound of albuminoids that she consumes.

The following is the German table of feeding standards: —

What Cattle require daily.

1,000 Pounds Live Weight.	Digestible.		Nutritive Ratio.
	Albuminoids.	Non-Albuminoids.	
Oxen at rest,	0.7	8.37	1:12
Oxen working,	2.4	14.45	1:6
Oxen fattening,	3.0	16.55	1:5.5
Cows giving milk,	2.5	13.50	1:5.4
Horses, light working,	1.8	12.70	1:7
Growing cattle,	2.5	15.00	1:6
Sheep fattening,	3.0	16.45	1:5.5
Swine fattening,	4.0	24.00	1:6

There is a question that is being discussed at the present time, namely, whether we need so narrow a "nutritive ratio," or stated another way, whether we need two and one-half pounds of albuminoids and thirteen and one-half of non-albuminoids, or whether less of the former and more of the latter will not do as well.

As long ago as 1888, in Bulletin No. 4 of the New Hampshire Experiment Station, I said: "I am satisfied, from the feeding experiments that have been conducted on our college farm, that a considerable variation from the foreign standards may be economical, and that instead of 1 : 5.4 we can do better with a nutritive ratio of 1 : 6 or 1 : 7. This may be considered a pretty wide variation, but I believe that the cheapness with which we can produce starchy food (non-albuminoids) makes these wider ratios more profitable."

Again, in 1889, Bulletin No. 8, New Hampshire Experiment Station, is the following: "I am of the opinion that if we get the "nutritive ratio" anywhere between 1 : 6 and 1 : 7 we shall still have a well balanced ration."

At the Wisconsin Experiment Station (1893), as a result of extended inquiry among the best farmers, it was found that a nutritive ratio of 1 : 7 was most profitable.

These facts do not at all affect the principle involved, but simply show that for American conditions the standard should be wider than for German; and if the American farmer feeds a ration containing from two to two and one-quarter pounds of digestible albuminoids and from thirteen and three-quarters to fourteen pounds of non-albuminoids, he will be very close to the perfect practical ration.

HOW SHALL THE PRACTICAL FARMER MAKE USE OF THE EXPERIENCE OF OTHERS?

No great good can come from the feeding standards alone; to be sure, they tell what the cow or ox or hog requires, but how to supply this amount and kind is a question not yet answered, and it is to this that I would now direct your attention.

We must first have a table showing the composition of foods; the following is based upon American analyses, and gives us about all the foods commonly found on New England farms.

What Fodders contain.

100 POUNDS OF	DIGESTIBLE.		Nutritive Ratio.
	Albuminoids.	Non-Albuminoids.	
Mixed hay,	3.71	47.61	1 : 12.8
Clover hay,	7.53	43.60	1 : 5.7
Oat straw,	1.45	43.31	1 : 30
Corn fodder,	2.15	41.38	1 : 19
Ensilage,	1.47	14.80	1 : 10
Corn meal,	7.78	71.60	1 : 9.2
Linseed (new process),	28.57	44.30	1 : 1.5
Cotton-seed,	31.36	42.26	1 : 1.3
Shorts,	13.26	52.70	1 : 4
Middlings,	13.35	57.72	1 : 4.3
Gluten,	25.14	61.90	1 : 2.4
Skim-milk,	3.23	6.94	1 : 2.1
Wheat,	9.50	65.65	1 : 6.9
Salt marsh hay,	**2.27**	**45.83**	**1 : 20**

Let us study this table for a moment. Taking all of our more common foods that are raised on the farm and averaging their composition, we find that the "nutritive ratio" is as 1 to 14; that is, for every pound of albuminoids that we raise we get fourteen pounds of non-albuminoids; but for milk production at most we cannot make use of more than seven pounds of the latter to one of the former, so we must conclude that we are raising twice as much starch, sugar, oil, etc., as we can profitably use.

But how shall we correct this? The answer often given in practice has been, and is now, many times, feed cornmeal; but cornmeal is also too plentiful in starchy compounds, having over nine pounds to one of albuminoids; it is therefore utterly unsuited to the duty of supplying the natural deficiency in our coarse fodders. The true, scientific and practical method of supplementing these fodders is to take some food having an excess of albuminoids, thus making the excess of the one compensate for the deficiency of the other; and we may select from the following: cotton-seed meal, gluten, gluten feed, linseed (new or old process), wheat, middlings, shorts, etc.

We are now in position to consider the actual compounding of rations, and may ask the question, How shall a farmer make use of the feeding standards and table of feeding stuffs?

For a concise answer I would say, Use it just as your wife uses her cook book. It gives you the same information relative to feeding a cow that the cook book gives her when she makes cream pie, that is, it tells the amount and kinds of digestible material that a cow ought to have to produce good results. It doesn't pretend to be the only combination from which good results may be expected, any more than Hood's cook book pretends to have the only combination of cooking materials which will make cream pie, but it is based on hundreds of practical feeding experiments, and may be accepted by any farmer as a good, safe, practical guide to work by; and if every milk-producing cow in Massachusetts could be fed this winter by this table, there would be an increase of more than one-fourth in the milk and butter produced. Now, isn't it worth trying?

How to adjust Cost of Food and Value of Product in Most Profitable Relation to Each Other.

The limit of *profitable* feeding is fixed first of all by the cow herself; but the relative cost of food and value of product modify this limit to a considerable extent. Let me illustrate this. A given cow may be able to consume daily fifteen pounds of digestible dry matter, and she may produce a can of milk at a cost of fifteen cents; the same cow may easily be induced to consume twenty pounds of dry matter, but the milk yield may only be increased a trifle, so that the cost of a can of milk is eighteen cents. Or the food supply may be cut down to thirteen pounds per day, and the shrinkage be so little that the cost of milk shall amount to only fourteen cents. Now, if a further reduction should show an increase in the cost per can, then we may assume that the limit of profitable feeding with that cow is somewhere in the vicinity of thirteen pounds of dry matter per day. Another cow side by side with this one may be able to consume twenty pounds, and still produce milk at the lowest cost which in her case is attainable. The two cows have different capacity for turning food into milk. Now, as we approach the limit of a cow's capacity to do profitable work for us, we must feed with greater care; and under these circumstances it is the little things like a few cents difference in cost of grain or the substitution of a nitrogenous for a non-nitrogenous food that show the skill and intelligence of the feeder.

Again, as the cost of food and value of product come closer and closer together, the cost of every item of food must be counted with greater care. If milk brought fifty cents per can, instead of twenty-five cents, then we might indulge in more of extravagance in feeding; but when the cost of a day's keep is twenty cents and the milk sells for but twenty-five cents, the margin is so narrow that the greatest care must be exercised if we are to show a balance on the right side at the end of the year.

SALT HAY.

The product of your acres of sea-lands is to you an important one, even though only local in its bearing upon Massachusetts agriculture. A yearly harvest fertilized by the great ocean, requiring no outlay except for ditching the land and securing the crop, but it is of little use unless you feed it in such a way as to get a profit out of it, and this you can do if the principles of feeding above set forth are regarded.

Salt hay, while varying greatly in quality according to the character of the growth and the elevation and location of the marsh, must be judged from its average composition as it comes to the barn, — not what it might be if better protected, etc.

The table of food composition gives it as poor in albuminoids, and therefore classes it with fresh meadow hay, straw, corn fodder, etc.; and in compounding it into rations we must be guided by the four principal conditions under which it is likely to be fed: —

1. Where salt marsh hay is to be the only coarse food used. This is not the best condition, but as there are some and perhaps many who use it in this way, I give one ration which may be of use.

Ration A.

	Albuminoids, Pounds.	Non-Albuminoids, Pounds.
15 pounds salt hay, furnishing, ...	.33	6.80
3 pounds cotton-seed meal (one and three-quarters quarts), furnishing, . . .	.94	1.27
3 pounds gluten (two quarts), furnishing, .	.75	1.84
4 pounds wheat (two and one-half quarts), furnishing, ...	.38	2.62
2 pounds corn meal (one and one-half quarts), furnishing, ...	.15	1.43
Total, ...	2.55	13.96

2. Where salt hay and English hay are to be combined.

Ration B.

	Albuminoids, Pounds.	Non-Albuminoids, Pounds.
10 pounds English hay, furnishing, . . .	.37	4.76
10 pounds salt hay, furnishing, ...	.23	4.58
2 pounds cotton-seed meal (one and three-quarters quarts), furnishing, . . .	.63	.84
3 pounds gluten (two quarts), furnishing, .	.75	1.84
4 pounds wheat (two and one-half quarts), furnishing, ...	.38	2.62
Total, ...	2.36	14.64

Ration C.

	Albuminoids, Pounds.	Non-Albuminoids, Pounds.
10 pounds English hay, furnishing, . . .	.37	4.76
10 pounds salt hay, furnishing, ...	.23	4.58
2 pounds cotton-seed meal (one and three-quarters quarts), furnishing, . . .	.94	1.27
1 pound gluten (three-quarters quarts), . .	.25	.62
2 pounds linseed (one and one-half quarts), .	.57	.88
4 pounds middlings (three and one-half quarts),	.53	2.30
Total, ...	2.58	13.98

3. Where ensilage is a part of the ration. This is the most desirable condition of all. The use of ensilage invariably gives animals a desire for coarse fodder, and there is little difficulty in getting them to eat up the coarsest of foods which otherwise might be left but half consumed; and the best advice I can give to those of you who have salt marsh is to devote enough of your uplands to the raising of corn, so that you may house at least three tons of ensilage for each ton of salt hay you propose to feed.

Ration D.

	Albuminoids, Pounds.	Non-Albuminoids, Pounds.
30 pounds ensilage, furnishing,	.44	4.42
10 pounds salt hay, furnishing,	.23	4.58
2 pounds cotton-seed (one and one-quarter quarts), furnishing,	.63	.84
3 pounds gluten (two quarts), furnishing,	.75	1.84
3 pounds wheat (two quarts), furnishing,	.29	1.97
Total,	2.34	13.65

Ration E.

	Albuminoids, Pounds.	Non-Albuminoids, Pounds.
30 pounds ensilage, furnishing,	.44	4.42
10 pounds salt hay, furnishing,	.23	4.58
2 pounds cotton-seed meal (one and one-quarter quarts), furnishing,	.63	.84
3 pounds linseed (two and one-quarter quarts), furnishing,	.85	1.33
3 pounds middlings (two and one-half quarts), furnishing,	.40	1.74
Total,	2.55	12.91

These rations are full ones for one-thousand-pound cows, but would probably prove ample for cows weighing eleven hundred pounds; for cows of nine hundred pounds weight from fifteen to twenty per cent less may be used.

QUESTION. What quality of salt hay have you analyzed?

Professor WHITCHER. I have had all three varieties analyzed. I find there is a great difference in them. They are classified as low marsh, high marsh and thatch. The results of analyses I have given are the average of all analyses obtainable. They vary somewhat, but not as much as you would expect. I think you would rather have the black grass than either of the three, but on different marshes the classification is different. The tide has different effects, and all I can give you is the general result.

Mr. Little. I would like to ask if there is value in feeding apples?

Professor Whitcher. Yes, there is no question but what there is value in apples. It has been found that apple pomace in many cases has been almost as valuable as corn ensilage for feeding. There is a limit beyond which you cannot go in feeding. If you undertook to feed cattle wholly on corn meal, you would make a failure of it. If you undertook to live on mince pie or candy, you would make a failure of it. The thing to do is to feed a suitable variety, and in feeding apples you must not go to the extreme. I had a letter a short time ago from a creamery man, who asked if I thought feeding apples made a bitter taste in butter. If a cow feeds on apples until she has got herself in a physiological condition that borders on disease, she cannot produce good milk; but if she is fed a reasonable amount of apples and a reasonable amount of ensilage, roots and other things that go to make a good ration, there is no difficulty. Apples are good to some extent, and, judging from the effect of apple pomace as ensilage, I should say that their feeding value would be pretty well up with the feeding value of roots.

Mr. Little. Does the lecturer think that the value of salt hay can be as well shown by a comparison with English hay as by a comparison with some other food articles?

Professor Whitcher. Yes, I think I can get the best results in that way.

Mr. Morrill. I have seen two cows taken from pasture six weeks ago and fed on pure salt hay, and nothing but that, with what water they wanted, and they are looking well and gaining every day. Where they have the right quality of salt hay, they will eat it up clean.

Professor Whitcher. This matter is a relative one. They may have been taken from a pasture of such a poor nature that they made a gain. I am aware that different people get different results, and there is a difference in the value of salt hay, just as there is a difference in rations of other kinds. One man might get results that another man might not be able to get; but in general I should say that salt hay is not a good ration to keep cows on the whole year.

Mr. HOYT. I am feeding a herd of dairy cows for the milk. I feed in the morning salt hay with one quart of cotton-seed, one quart of gluten and two quarts of shorts. At noon I feed corn fodder; at night the same quantity of grain; and I am satisfied that I am not using the right ration, and would like to know where I fail.

Professor WHITCHER. I think you cannot afford to feed that amount of shorts when other grains are as cheap in relation to shorts as they are this year. For instance, I suppose you pay about seventeen dollars a ton for your shorts. You can buy Buffalo gluten feed for $20. What I have used for comparison is Pope's cream gluten. It is the best I have ever used. Now, to go back to the question as to what change you can make, I should not feed that amount of shorts. Of course, if you have tried it and find you get better results from that than you do from any other grain, that settles it, but I should not understand it. I should rather have the same amount of money put into middlings than into shorts. I would rather have whole wheat than either.

Mr. DECKER. What does the gentleman mean by shorts?

Professor WHITCHER. Wheat bran.

Mr. STETSON. Would you use corn fodder from which the corn has been husked?

Professor WHITCHER. There are some difficulties in the way of feeding corn fodder. It is in a very variable condition, — generally a bad condition. It is hard to cure so that it won't mold after it goes into the barn; but if you have it in good condition, it may be used with good results. As to feeding corn fodder, I would not attempt under any circumstances to use it alone. I would feed it in such a combination as ration B, using ten pounds of English hay and ten pounds of corn fodder, and then in addition to that I should use this same grain ration. Of course I might figure out one hundred different rations, varying the proportions, using some corn, but I refer to this as a typical ration. I would use this ration B. I would pay three dollars a ton more for this, if there was a difference of three dollars a ton between middlings and shorts. If I was feeding a very small amount of coarse fodder and a very large amount of grain, I would feed some shorts where otherwise I should not; but in any system of feeding which I am talking about to-day, that is, coarse fodders, I should not use shorts, I think, or bran. I should not use those, because I think at the price they sell for they are not the most profitable food.

Mr. LUNT. With labor costing twenty-five dollars per month and board, and when salt hay can be put in the barn for five dollars a ton, would you advise a farmer to raise ensilage on land worth one hundred dollars an acre, with the same labor?

Professor WHITCHER. If a man has land that is worth one hundred dollars an acre, he has got to do something with it. He does not want simply to look at it. He has got to get an income out of it. Perhaps in most cases a man would be raising hay for the market; but I think the system of farming which takes in a certain amount of cultivated crops is the best. It may be a man who is close to a city can use that land with greater profit than in raising ensilage by raising certain things that there is a call for locally; but for the general run of people I should say he could afford to raise corn on that land in rotation. He gets two advantages: he tills his soil, and gets it into condition to raise hay.

QUESTION. Whether those rations are for the production of milk or for cream, in case we raised milk and did not carry the milk to the creamery?

Professor WHITCHER. Well, it is six of one and half a dozen of the other. When you feed a well-balanced ration to any given cow, she will give you a normal supply of milk, and as to that milk, it does not make much difference whether you feed one or the other of these rations; if she is a cow that is going to give milk that has four per cent of fat in it, she will give that quality of milk, and any natural system of feeding would not affect that result.

QUESTION. Do you find any difference in wetting the shorts or feeding dry grain?

Professor WHITCHER. My experience for the last ten years in feeding has been in connection with ensilage; and that question of wetting is different in that case than it would be if we were feeding with dry fodder. For instance, a cow will consume not quite half the water at the trough when she is eating ensilage that she will if she is on dry fodder, so there is not the necessity of wetting the grain. I do not know that there is any necessity of wetting grain under any circumstances, but in feeding ensilage I know there is no necessity of wetting.

QUESTION. I would like to inquire what the difference in value would be between a certain quantity of salt hay and an equal quantity of swale hay.

Professor WHITCHER. That question about swale hay is very similar to a question, how much a cord of wood is worth. It depends upon whether it is hickory wood or pine. Swale hay, as you know, is very variable. Some kinds of swale hay are worth more than herds grass hay.

QUESTION. Why so?

Professor WHITCHER. Because it will produce more milk. Straight herds grass I consider a pretty poor hay for the production of milk, but some people do not.

Mr. C. E. WARD (of Buckland). In Franklin County we produce milk for butter, and also to sell. Those who sell milk will not feed cotton-seed, but feed largely of bran, while the men who are in the creamery feed cotton-seed. Do you consider the bran feeders are at fault? They think that, while cotton-seed will not increase the quantity of milk, it will increase the richness of the milk.

Professor WHITCHER. I think they are mistaken. I made the statement to the Vermont Dairymen's Association ten years ago or more, that if they would appoint a committee of ten men who would agree on some one method of feeding that would increase the per cent of fat in milk by one-fourth of one per cent, I would test thoroughly and report the results to them. They did not produce the ration they wanted me to feed, but I did carry on a long series of experiments of feeding a very one-sided ration, a ration which contained nothing but corn meal, another containing nothing but gluten meal, and feeding others that had cotton-seed; and I have never yet found any ration that would change the percentage of fat in milk beyond what the change would be with the same ration. That is, if you feed a cow on exactly the same food from day to day and week to week from the period of milking to the end, she will vary, sometimes accountably and sometimes unaccountably, the amount of fat in her milk. That is on the normal ration; but I never have found a ration on which I could say I could increase or decrease the amount of fat she would yield on a normal ration. I feel confident that the per cent of fat is not easily varied by a change of food, even by a radical change of food; and I doubt if it is possible to change it by one-fourth of one per cent.

QUESTION. Should we feed grain in the morning on an empty stomach, or feed this coarse fodder first, water the cows, and feed grain immediately afterwards?

Professor WHITCHER. I would feed ensilage the first thing in the morning. I would give a grain ration while milking. Some cows can be milked much better while they are eating grain, and some cannot.

Mr. ——. I do not want mine to eat anything while milking. I want them to attend to me when I am milking.

Professor WHITCHER. If your cow is keeping her mind intent on you, occasionally she will kick you over. If her mind is pretty intent on the grain, the chance of her being disturbed while being milked is very much less; but that is a matter of bringing up. I would have them eating their grain all the while they are being milked. I would not feed the grain on the ensilage.

Mr. APPLETON. What is the objection?

Professor WHITCHER. Well, in the first place, there is more or less waste of ensilage in any system of ensilage feeding I have ever seen, and some grain would be wasted if it is fed with ensilage.

Mr. J. Q. EVANS (of Amesbury). I am somewhat disappointed that this discussion has drifted so far away from salt hay. I hoped it would be devoted to that exclusively. Our State Board has given but very little attention to the subject lately, and I wish the speakers would come back to the question that is properly before us.

Secretary SESSIONS. I think Mr. Evans' criticism is highly to be commended. We shall have a lecture to-morrow on summer and winter feeding of dairy cows. The question this afternoon is as to salt hay and the comparative value of salt hay.

Mr. NOYES. You spoke of feeding cows on straw.

Professor WHITCHER. Yes, sir.

Mr. NOYES. I want to know if you give the same ration of straw with grain that you do of salt hay?

Professor WHITCHER. Practically about the same.

Mr. NOYES. When do you feed straw to the cows?

Professor WHITCHER. I give it at night and let them meditate on it, and they will eat it.

Mr. NOYES. Starve them to it?

Professor WHITCHER. Oh, no, sir; I do not believe in starving cattle. They gain in flesh and in milk.

Mr. NOYES. Do you think straw is as valuable as the same amount of salt hay?

Professor WHITCHER. I do not know that it is, but I think it is.

Mr. ——. There is one matter in relation to this salt hay feeding which has not been touched upon, and that is the amount cows will drink after eating salt hay; and in that connection it seems to me it has a great deal to do with the amount of milk they will give. Perhaps you can enlighten us as to whether the amount of drink the cow uses affects the amount of milk.

Professor WHITCHER. The more water you can get a cow to consume daily, the greater is the activity of the tissues in the body, and therefore the greater the amount of milk, — not that water produces milk, but the water stimulates the organs of digestion and assimilation.

Mr. NOYES. I know that as we get our salt hay off the marsh there is a good deal of it that is damaged. I have hauled off twenty tons at a time and put it in my barn, and found, as I unloaded it, that there was quite a lot of it damaged. I have fed my cows on that damaged hay for a week or ten days, to get it out of the way, and they never shrank a bit in their milk. Some of it was black, and they ate every bit of it.

Professor WHITCHER. I have seen a great many cases where people would feed damaged ensilage and corn fodder, and get good results; still, I think most of us would prefer not to use it. It reminds me of what a friend of mine said, that he had always noticed that people who believed that corn ought to be frostbitten before it was put in the silo were people whose corn was frostbitten before harvesting.

Mr. EVANS. I have been sorry that, on a matter of such great importance, after looking through our agricultural literature, we could find but very little assistance in the matter of feeding salt hay. I find that our State Board reports and the reports of other meetings say nothing about it. There has been something occasionally about draining salt marshes, but they are silent upon this matter of feeding salt hay. Now, as has been said here, it is a local matter, and yet it is a matter of more importance than a great many in this audience would believe. I find by the State census of 1885 that in this Commonwealth there are over 23,000 acres of salt marsh, yielding hay every summer to the value of $200,000. That is no small interest, and that applies particularly to Barnstable and Essex counties. I find that in Barnstable County there are four towns which cut over 500 tons each. I find in Essex County there are seven towns which cut over 500 tons each, and I find that the town of Newbury leads the record of the Commonwealth by cutting 3,500 tons annually. Now, that is no small crop to consider, and it must affect the agriculture of this section; it cannot be otherwise. We hear considerable about the tobacco crop of this Commonwealth, and yet the salt hay, according to the census of 1885, is almost one-half the magnitude of the tobacco interest, and we consider that crop very important. I was a little surprised to hear about the analysis which the professor presented. I believe he said it was from the experiment station of this State.

Professor WHITCHER. I ought to correct that by saying the results of analyses in this State are averaged in the figures I gave. The average of all analyses of salt hay, — and that is a very indefinite term, — gave 4.75 per cent of albuminoids, while black grass gave 6.75 per cent albuminoids. You see black grass averages one-half again as high in albuminoids as salt hay.

Mr. Evans. I will speak just a moment on this matter of black grass. It is something which the farmers of Newbury think a great deal of. Presumably one-half of all the hay they cut is black grass. The origin of black grass on these marshes is peculiar. Something like one hundred and fifty years ago it was found growing in a few isolated spots, and during later years, perhaps through the annual cutting of the marshes or for some other reason, it has been spreading all over the marshes, so that at the present time nearly one-half of the marshes of Newbury are in black grass. In the town of Salisbury I find there is not nearly so much black grass. We have it on the margin, but not on the marshes as a whole. In regard to the magnitude of these marshes I will say a word. Newbury is situated right in the centre of an immense tract of salt marsh, running on the one hand from the Gloucester region north into Hampton, N. H. Within this county in this one tract of marsh we have over 9,600 acres, and I presume that in Rockingham County, N. H., there is nearly as much more. It is really an immense tract of land for this particular crop, and whenever the time comes in future years that this land is reclaimed, we are going to have the banner mowing land of the Commonwealth, but I do not think we should attempt to reclaim it at present. We have land enough, and we should devote the salt marsh to the use for which it is fitted, and annually reap its harvest. There is no necessity of tilling the soil of the marshes; we only go down at the right time and cut off the harvest. You may call it almost the harvest of the sea. In the matter of harvesting, the application of machinery is doing away with the old methods of swinging a scythe. The bringing in of the horse and mowing machine and horse rake has taken away much of the terror of this work, and we find, while it is rather more difficult to handle than our upland grass, a little brain has been put into it, and by the use of machinery we are gathering in its products. When a gentleman said here that salt grass could be harvested for $5 a ton, I could say that on my land, fifty-five acres, which is three miles from my barn, the average cost of harvesting and putting in the barn was about $4.50 per ton.

Question. How much does it average to the acre?

Mr. Evans. Just about one ton. The census for Massachusetts shows .96 ton to the acre. I believe that it is of more value than the professor has shown. I believe that good results can be obtained by feeding a good quality of salt hay almost exclusively, but I do not think it would be advisable to do that. It may be a waste of feed, but I think it can be done, and the cattle will go out in good condition; but with a combination of ensilage and grain, I believe it is by all odds the cheapest food that we can give our cattle, and I believe it is as well relished by the cattle as any coarse fodders that can be named. It is practically all eaten up, which we cannot always say of straw; and I have the utmost confidence in saying that it has done more for the agriculture of the coast sections of this Commonwealth than any other crop.

Question. Are these marshes owned in large sections by the farmers in this immediate vicinity?

Mr. Evans. They are mostly in small holdings, and are owned by the farmers living at a convenient distance. A man living back twenty or fifty miles would find himself at a great disadvantage as compared with a man living within three miles or five miles, because he would be too far away to go to his work in the morning and return at night.

Question. I would like to ask Mr. Evans on about what proportion of these marshes machinery can be used.

Mr. Evans. I find in my section that two men will just about do the trimming out while I mow the best of the land. Three men, a machine and horse, will cut from eight to ten acres a day, and I live three miles away from the marsh.

Question. Are those marshes all so you can go on with a horse?

Mr. Evans. Yes, but some marshes are worse than others; some are full of creeks and ponds, and some are large tracts. My own marsh is situated on the further shore of a river, where I have to boat my horse across. The river is perhaps fifty or seventy-five feet wide.

Secretary Sessions. You have some contrivance for keeping your horse from miring, have you not?

Mr. Evans. Yes. Our marshes are so soft that I can take an ordinary hand rake and run the handle down into the marsh clear to the head of the rake. Where the sod is firm along the banks of the creeks a horse can often travel without shoes for a little distance, but on most of our marsh he would mire immediately if he did not wear bog shoes. The shoes I use are of hard wood, ten inches in diameter, and clamp onto the hoof by a thumb nut in front. Even with these shoes it is not rare that a horse gets mired. This is, however, one of the expected circumstances.

Mr. Clements. I think salt hay in some quarters has been very much underrated, and possibly for the reason it is not cut early enough. Reference has been made to black grass. I was in the habit with my father, twenty-five or thirty years ago, of cutting twenty-five or thirty tons of black grass every year. It blossoms early, and it should be cut in June or early in July. We were in the habit of cutting it for sheep. We kept a lot of breeding ewes, and I think it was as good for them as upland hay. We fed it during the winter months to the breeding ewes, and they were kept in good condition, with a few roots, no English hay at all. I think if we cut our marshes when they should be cut that we should have much more value in our salt hay. If that early cut black grass from the meadows around Newbury could be analyzed, there would be found to be more virtue in it than is generally supposed.

Secretary Sessions. We have an experiment station which would be glad to analyze some of this hay, and if you gentlemen would attend to the selection of samples, they will be analyzed for you.

Mr. Evans. Mr. Chairman, there is a great difference in samples of salt hay, and I have never placed confidence in analyses that have been published, for that reason. We find often that the grass on our low marshes, which we call river marshes, is being fed to milch cows, while on our higher marshes there is wire grass that we find better adapted for horses. I do not know the reason, but that is the conclusion we have arrived at after years of experience. I think also that location, and the average run of the tide, give a very different quality to grass. I would say here to any of the audience who are not familiar with the fact, that the tides twice a day fill the creeks to within a foot or a foot and a half of the surface of the marsh, and the high tides which we sometimes have cause the grass to be submerged, so we have to take advantage of low tides for cutting the grass. The marsh is so saturated with water that it would be impossible for us to dry the hay on the marsh and cart it away. That is why hay is stacked on the marsh instead of being brought ashore, and we also find we can put it into stacks in much less time than we could get it ashore. If we can get it in the stack away from the tide, we can then take our leisure in the months of October and November in hauling it ashore.

Question. How long does it take you to stack it?

Mr. Evans. Well, in my system, the first two days I mow all day; the third day I mow until noon time, and from that time on use the afternoons in getting it into the stack as fast as possible, — from three days to a week from the time it was mowed until it is got into the stack. Early black grass requires a much longer time to cure than late grass.

Mr. Clements. The manner of curing salt hay is very similar to that of curing all other hay. I remember once when I was cutting some black grass there was no moisture on the hay. I hauled it into the barn, but I soon found it was wet. I could shake water out of it. I thought it was all spoilt, but I found afterwards it was as good as any hay in the barn. The salt hay we have been talking about here all the afternoon comprises very many kinds of grass. That which we call the black grass grows up near the uplands, and blue grass, fox grass and two or three other kinds grow in other situations; and they are all different as to their feeding qualities. Some of it makes a very fine hay for horses. I know that Mr. Edward Little used to winter a great many horses on salt hay and a little grain, and brought them out in good condition. It is the experience of almost all Newbury farmers that they can carry their dry cattle in very good condition with salt hay. Speaking of hay being damaged, I remember an instance that happened to me once. I had a lot of grass out on Plum Island that I cut, and stacked on the meadow. The hay was put up in rather poor condition, and it stood there in the stack. Next year I cut the same lot again, and it was as bright as a dollar, and I put it in the barn. I sold the two lots of hay to Mr. Newhall of Lynn. I got a dollar or two more a ton for that in the barn than I did for the other. He said to me afterwards, "I made a mistake when I bought that hay of you. I paid you most for the bright hay. The damaged hay was a great deal the best." I have often heard it remarked that salt hay that is more or less colored will feed better than bright hay that is put in the barn dry. I think all the farmers will tell you that salt hay does not want to be too dry and hard.

Secretary SESSIONS. I think you gentlemen here who represent the salt marsh owners around Newburyport ought to have an analysis of all these kinds of salt hay made by the experiment station, and the result put on record, so that people may know what they are talking about when they talk about salt hay.

QUESTION. Will the gentleman tell us what is the estimated value of a ton of salt hay?

Mr. LUNT. Well, it varies. I have known it to sell from twenty dollars to five and six dollars.

Mr. LITTLE. I think the last speaker is in error in regard to the price of salt hay as compared with English or herds grass. It seems to me there is not distinction enough made between the different qualities of salt hay. It varies in the different localities in which it is cut. We distinguish between black grass and salt grass, and I think good black-grass hay about here sells for about two-thirds the value of English hay. If salt hay is taken from the marshes and hauled to the upland and cured, the quality of the hay is not so good as when it is cured on the marshes. There is not the fragrance about it that there is where it is cured on the marshes. It is said that it damages badly in stacks. When salt hay is properly stacked the damage is almost wholly confined to a few pounds, perhaps one hundred pounds on the average, on the top of the stack; and once in a great while, when we have an extra high tide, a small portion of the bottom of the stack will be injured, but the bulk of the hay in the centre of the stack is good. If it is properly secured when it is put in the stack, it keeps better than it does if it is put in the barn.

Mr. EVANS. In regard to the matter of salt in salt hay, it varies exceedingly. For instance, when we have had very little rain and a high run of tides immediately before cutting, we frequently see the salt hay with the crystals of salt on it so they will fairly glisten in the sun. At other times when we have had a low run of tides and there has been a recent rain, you can scarcely taste it. Therefore in any analysis it would be very important that the condition of the grass at the time of cutting should be known.

Professor WHITCHER. There is another difficulty the chemist has to deal with. He has to deal with hay as farmers use it, and we have to go to the hay stack and take hay you are going to feed. We cannot take selected samples and put them under our coats and keep them out of the rain, and cure them as you would a bunch of herbs; but we have to take an average sample of hay, and then we have what you are talking about, not ideal hay. The analyses I have given here to-day may seem low; still when you take into consideration the question of digestibility, I think they are not misleading.

The CHAIRMAN. Gentlemen, I regret very much to cut off a discussion that seems interesting, but it is getting late, and I must bring this meeting to a close. We will now adjourn until half-past seven o'clock this evening.

EVENING SESSION.

The evening session was opened at 7.30 o'clock, by the first vice-president, Hon. JAMES S. GRINNELL, who said: —

The subject this evening, as you know from the programme, is "The nutrition of soil, plant, beast and man," to include advanced methods of cooking food, with a practical demonstration, by Mr. Edward Atkinson of Boston. Mr. Atkinson is known not only to you but to all the people of Massachusetts and to all the people of the civilized world, wherever the English language is spoken, certainly, and perhaps in other places, as one of the advanced theorists and writers and benefactors of the family. He has a great subject here, and has, I suppose you understand, to begin with, some nutrition in process of preparation. He will instruct you how it can be applied to all. I take pleasure in introducing Mr. Atkinson of Boston.

Mr. EDWARD ATKINSON. Ladies and gentlemen, I think my first duty is to make an apology for Mr. Appleton in having asked me to come here. We are very sorry because of his absence to-night, and he would have apologized for himself had he been here. He happened to be at the University Club in Boston one evening when I was called upon to make a demonstration with this apparatus, and prove that one of my office boys who never cooked anything before could serve seven or eight kinds of food, thoroughly and nicely cooked, from under that box; and he was so much interested in the matter that he ventured to ask me to consent to come here, and here I am.

Some of the processes have been going on in this apparatus all day long, and some are going on at the present time. I ought also to apologize a little for my own method. The last time, I believe, that I spoke in Essex County, was at a political meeting, where the gentleman who had accompanied me had dined out, and had taken a little too much champagne. I spoke first and put in the facts; he spoke second and put in the fireworks; and the account which an old lady gave to Collector Russell, as he said (I think he invented it), was that the old lady said it was the funniest meeting she ever went to, — the first speaker was very dry; the second one had been. Now you know what to expect.

THE NUTRITION OF SOIL, PLANT, BEAST AND MAN.

BY MR. EDWARD ATKINSON OF BOSTON.

Gentlemen of the State Board of Agriculture: — Although I have been working on the subject of nutrition many years, I have not yet got over the sense of a certain grotesque aspect of my own case, in that it should have fallen to one who can claim neither a scientific knowledge of the chemistry or physiology of nutrition, nor of agriculture, nor of cooking, to take a somewhat prominent lead in the development of these subjects. It simply proves that a duffer may enter in where science fears to tread, who, not being afraid of sometimes exposing his own ignorance, may start many lines of thought and of practice for which the time is ripe. You will probably find much in my address that will simply indicate ignorance on my part of matters which may be well known to many of yourselves; but it may also happen that one who can claim a scientific method in bringing the work of other people into its true relation, and in presenting it in a way that every-day people can comprehend it, can do some service on the lines with which we propose to deal this evening. Of course in a single hour I can only touch upon the most salient points.

I am called to speak to you upon the nutrition of the soil, the plant, the beast and the man. In my several undertakings to convert the products of soil, plant and beast to the nutrition of mankind, my attention has been called to the fact that all these undertakings simply consist in the conversion of the same natural forces from one form into another. The instruments of conversion are land, plants and bodies. Next it appeared to me that unless we could comprehend all the phases of this conversion, we should waste a vast deal of energy. The objective point of all science is the conservation of energy.

It next became apparent to me that the nutrition of the soil is a very complex problem, for the very simple reason that soils vary so much in their natural attributes as to render their treatment one of selection among various nutrients or fertilizers all of which substantially belong to the same classes, these classes being very few in number. In a broad and general way we may say that the soil requires carbon, lime, potash, soda, phosphoric acid and nitrogen; but, as soils vary in being already composed in part of these materials, the nutrition of the soil is a difficult and complex matter; yet success in agriculture is coming more and more to rest on the development of this branch of agricultural science. How to add the missing element in order to develop the force already existing in each farm is the matter of importance.

Next we come to the plant; and again the nutrition of the plant is more complex than the nutrition of the beast. The plants derive their growth in varying proportions, according to the relative quantities of carbon, alkali, nitrogen and phosphate with which they may be supplied. It seems to me that it is or will be a more simple matter to comprehend the nutrition of the plant than of the soil and to bring it within rules of general application.

Next we come to the nutrition of the beast, and here we reach much simpler conditions. We know that the food of animals must consist of certain nutrients which we call starch or carbo-hydrates, albuminous or nitrogenous food which we call protein, and fats which are carbonaceous which we call fats. To these must of course be added the lesser, mostly mineral elements, which, dealt with quantitively, are apt to be found in sufficient quantity in the various kinds of food with which animals are fed, a little discrimination being called for in supplying lime for bones or egg shells. The variation of this simple problem of feeding animals consists in discriminating among them so as to produce certain results. We feed the same nutrients, but in varying proportion, in order to produce milk, meat, fat, eggs, wool, etc.

Up to this point science has been assiduously applied, and very great progress has been made; calling, so far as I may judge, rather for a concentration of the information already existing and for its classification in a simple form in order to make it plain to the commonest understanding. Land is now being treated less as a mine which may be exhausted but more and more as a laboratory or instrument of production which will respond in its product in proportion to the intelligence with which it is made use of as an instrument rather than as a direct source of production subject to exhaustion.

If I am rightly informed, greater progress has been made in Prussia than elsewhere in the classification of land, with such designation of its varying properties as may enable any one to choose the best places for the kind of product that he proposes to work this land upon.

Lastly, we come to the objective point of all the previous processes with which I have dealt, — to wit, the nutrition of mankind. At this point science seems to have almost stopped. I do not mean to say that there is not a vast deal of thoroughly well-digested scientific information to be found in many great works and in a few lesser or more popular books; but until very recently there seemed to be no treatise in the English language that could be brought within the comprehension of the ordinary mind, covering a true method of instruction in the nutrition of mankind; yet the nutrition of mankind is the simplest of the four forms or directions of the conversion of the forces which I have named. I have endeavored to meet this want by compiling the data supplied by my scientific friends and adding the results of my own somewhat empirical methods.

Mankind requires fixed proportions of protein, starch and fat, varying but little in their relation to each other; in the temperate zone varying in quantity rather than in kind, according to the amount of energy required for a given kind of work, as it may be manual, mechanical or mental. Several different tables of adequate nutrition have been prepared in Germany, in England and in this country. They vary mainly in the ratios of protein and fat, the American ration, so far as it is yet established, calling for a little more fat than the European standard, because of our exposure to colder temperature. But when these several standards of nutrition are reduced to calories or mechanical equivalents of heat, they come very closely together, — in fact, they are substantially alike.

In this we find an analogy to the development of organic life upon the earth. At the tropics, where heat is greatest, we find the most abundant and luxuriant vegetation, the greatest activity in the production of animal life, but also the most rapid decay and the least duration of vegetable forms. As we pass northward into the temperate zone, we find production requiring the application of energy somewhat in inverse proportion to the heat of the sun; we find that the crops of almost every kind can be kept longer without decay the farther north we get in the temperate zone; we observe that the fruits possess more flavor and will also keep longer, and that what we lack in heat we make up in conservation. As we go to the far north, we find the lack of heat made up by the conversion of more fat into human vigor in the nutrition of man.

In dealing with this subject I have been sometimes inclined to take a paradoxical position. I once addressed the Associated Boards of Trade of New Hampshire on the elements of material progress or wealth. I told them that historically the progress of any given body of people had apparently been in inverse proportion to their possession of natural resources. The wealth of Holland had become the greatest of any nation until the oppression of armies and of Napoleon built up a debt which has not yet been surmounted; yet the people of Holland not only make crops, but make the land itself on which the crops are grown.

The inhabitants of Massachusetts are probably the richest people as a body in the world; yet Massachusetts could not bread herself, as our Southern friends put it, for a week. In contrast, as I told my friends in New Hampshire, that State had the disadvantage of possessing some attractive natural scenery and could therefore live to some extent on fish and strangers, as they do in Florida, without as much exertion on their own part as we were called upon to develop in Massachusetts; therefore our people were better off than they were.

There is a certain phase of truth in this. I read in one of that strange Russian's articles, Prince Kropotkin, that the most prolific soil in Europe is to be found in the market gardens around Paris, where tenants resting a few years upon a bit of absolutely barren land or rock first make their soil, then make their crops, and then go on to make more soil for sale; holding their title for the time to building land on conditions which may enable them to remove the whole of their made soil when their tenancy ends.

I imagine that the most prolific soil in Massachusetts is to be found under the acres of glass in Arlington and Belmont; and I doubt if there are acres anywhere in this country yielding a larger if as large an amount of nutrition as these acres do. If there are others, they are of the same type in the neighborhood of other great cities; yet no man knows or would be rash enough to measure the potential in production of any single acre anywhere.

We hear of abandoned farms in Massachusetts and other parts of New England. Their very abandonment is an indication of the progress of agriculture in the same States; it means a transfer of energy to better positions for production. There are more abandoned farms in old England to-day than there are in New England, but for an entirely different cause. The abandoned farms of old England are in the highest state of cultivation, and of a high potential in their natural properties; but they are abandoned because our English cousins have not yet learned how to free the land of artificial conditions, or how to promote the progress of the laborer to the end that he may become an independent farmer.

If there is one conspicuous difference between this and other nations, it is waste. This waste is largely to be attributed to crass ignorance. It is only within very recent years that the waste of farmers upon farms, of millers in flouring mills, of packers of meat and of all who deal with the products of the soil has ceased to be most conspicuous; in many directions it has not yet ended. For instance, in the first pamphlet which I ever printed, entitled "Cheap cotton by free labor" (1861), I laid out theoretically and in advance the whole progress and value of the cotton-seed in all its variety of products, now worth $30,000,000 a year, then wasted. It was a pure theory; but the theory, being based upon adequate information, ultimately gained the sanction of all the practical men in cotton production, as theory always ought to and always will when it is well grounded. There is no man so sure of bringing practical results as a true theorist. It is not very long since what were stigmatized by the name of offal — the secondary products of grain — were cast into the river from the great flouring mills of Minneapolis; at the present time the bran of the wheat, forming a part of this secondary product, is worth more per ton than the whole wheat, because farmers have learned how to use it as food for cattle, but have not yet mastered in full the true theory of feeding wheat in the grain although great progress has been made this year. I advise you to send to the secretary of the Kansas Board of Agriculture, Topeka, for a most exhaustive report on that subject.

The straw was a few years since burned upon the field to get rid of it, and a part of it is so still. Flax is grown in the West in huge quantities for the seed only, because we have not yet learned how to separate the fibre from the straw with economy.

The waste of skimmed milk in this country is something enormous; it is almost a waste to feed it to hogs. I know of one farm on which an excess is used as a fertilizer. We have on our statute book in Massachusetts an absurd law which forbids a true improvement in our breeds of cattle. It is, as I believe, ignorantly held that the value of milk is in proportion to the animal fat or cream which can be taken from it; whereas we get more than all the fat that we ought to eat from other sources, and the real food value of milk is in the skimmed milk, in which nearly all the solids are left when the cream has been taken away. Honest farmers have been fined, as I am told, for bringing pure milk to market from Frisian cattle, — perhaps a better food than richer milk, — because it did not reach the fat standard of this restrictive statute. Yet the Dutch work almost no other breed. Wherever meat is scarce or in some respects unsuitable, as in some parts of southern Europe, the protein or nitrogenous element in the food of the common people is found in the conversion of skimmed milk into cheese; eaten raw, it is unfit for human use, but when properly cooked it is one of the most easily digested and nutritious kinds of food.

On this line I am led up to the special subject of the evening. Aside from the gross waste of food material, one of our greatest wastes in this country is the waste of heat in the process of cooking. More than one hundred years ago, Benjamin Thompson of Massachusetts, Count Rumford, expatriated from his own country by his Tory opinions, entered the service of the king of Bavaria, by whom he was ennobled, mainly for his services in the commissariat of the army and of the poorer classes of the people. Yet, scientist of high repute as he was, according to the standard of that time, he discovered by mere accident that if a low degree of temperature is applied a considerable time to the cooking of meats, the work will be done very much better than if it is done quickly at a high temperature. Proceeding upon that line, he went as far in the development of the true process of applying heat to the conversion of food material into appetizing and nutritious food as the discoveries and inventions of his day permitted. Had kerosene oil or gas been placed at his disposal, and had the invention of incombustible materials other than metal been then perfected, he would have completed his work and would have left nothing for me to do. I have unwittingly repeated work which he did more than a century ago, being led by the logic of the case; and I have unconsciously plagiarized upon his own words, as I find on reading his works subsequently to my own publications.

The whole secret in the development of the art of cooking consists in the fact that heat can be boxed up. You can hold water in a tight half barrel when it is placed open end up. You can hold heat in the same half barrel when it is placed open end down on a metallic table with a hole in it under which a lamp is placed. Being thus in possession of a receptacle for heat, which may be a half barrel, or a tin-lined soap box, or a paper bucket, or a box made from a quilt, like this one of sea-weed and brown paper lined with binders' board, or an Aladdin oven, one can retard in such a receptacle a given measure of heat, and may there convert it into the work of cooking; maintaining the heat at a fixed point by the mere control of the lamp from which the heat is derived. With that control every process of cooking becomes perfectly simple. Any intelligent boy or girl of grammar-school age can be taught how to do common cooking and how to make perfect bread in a week's practice, governed by printed instruction. Without such control of the heat, which is impossible in the iron stove or range fed with coal, the art of cooking in a simple, sure and effective manner is also impossible.

It is probable that I should not have been able to solve this question, had not my attention been called in my profession of underwriter to the necessity which exists for constructing safe, slow-burning factories and workshops, from which the extreme heat of summer may be excluded, especially in the upper or roof story, and in which the warmth generated for winter service may be maintained under uniform conditions. This method of construction has been solved in the most satisfactory manner at the least cost by the use of timber and plank in place of joists and boards; the timbers being set wide apart in solid mass sufficient to bear the strain, the roof being constructed of thick plank, which is the best non-heat-conductor.

I may say, by the way, that I can conceive of no greater improvement that could be made than by importing some of these ideas into the construction of your barns and cattle sheds, where you need light, warmth and good ventilation; and I shall be very happy to send some of our missionary documents in which we describe this mode of construction to any of you who will address a card to my office. My son, who is an architect, is developing the construction of schoolhouses and hospitals on these same lines, with great success and at large reduction in the customary cost.

Discovering the non-heat-conducting properties of wood, of wood pulp, of plaster board and of paper, I went on slowly but surely toward the simple solution of the processes of cooking. In these several examples which are before you the Aladdin oven is the best. My only disappointment has been that I have been unable to get the cost reduced to as low a point as I had hoped. "The Aladdin oven, — what it is, what it does and how it does it," is fully described in my book upon the "Science of Nutrition," published by Damrell & Upham. The instructions for making substitutes for the Aladdin oven, corresponding to the examples before you, have been printed and distributed over the country by the department of agriculture, Hon. J. Sterling Morton, secretary. My patents have been dedicated to open and public use in these documents. I have suggested to Secretary Morton the manifest absurdity of teaching the people of this country how to nourish the soil, the plant and the beast, thus bringing about the most abundant production of the best food in the world, and then leaving it to chance and to ignorance how that food material should be converted into nutritious and appetizing food. I have suggested the expediency of attaching cooking experiment stations to each agricultural experiment station throughout the country, forty-four in number, with one or two thoroughly developed food laboratories for the study of the higher branches of this science of which we have yet only mastered the alphabet. It will depend somewhat upon the response to these publications whether that suggestion is adopted or not. A large edition was printed in the first instance, in the expectation of meeting every demand; if I am rightly informed, that edition is exhausted, and those who send to Washington for copies, as any of you who choose to may do, may have to wait a little before receiving the copies of the new edition which is now being printed.

I will now proceed to deal with the practical part of the question. This is a standard Aladdin oven, of which the contents will presently be placed at your disposal. In this oven one can cook in a perfect manner from twenty-five to thirty pounds of food at one time, an average being about twenty pounds at one full charge. It will suffice for the preparation of fifty to sixty pounds per day of nine hours with the consumption of one quart of kerosene oil in a lamp corresponding to this Bradley & Hubbard lamp which is now working. This work will be done in three charges, say, one of meat and vegetables of twenty pounds, one of bread, twelve to fifteen pounds, one of soup stocks or other compounds of twenty to twenty-five pounds. The oven may be worked night as well as day with safety with a lamp of less power fitted with the Trench burner, the most scientific burner in use, in baking beans, Indian pudding and pandowdy, and in the preparation of soup stocks. One oven is going in my household practically all the time.

The work done in the oven is baking, roasting, simmering, stewing and sautéing. It is not worth while to use the oven for boiling, because that work can be better done without waste of the time of the oven, on a small metallic table outside over another lamp, and on that same table frying by immersion may also be conducted. The true art of frying is very different from that commonly practised in the American frying pan, which is, I believe, the chief source of dyspepsia. What is miscalled frying consists in putting food into a frying pan with a little film of fat which is sure to be raised to an excessive heat, saturating the food with what the chemists call "acroline," an indigestible and injurious product of highly heated fat, while the essential properties of the fat and food alike are dispersed through the house in the form of bad smells.

It is better for a person who can afford it to set up two ovens, or one complete oven and one of these substitutes as an auxiliary, although it is not necessary. One may be devoted exclusively to roasting and baking, the other to simmering and stewing, the heat required varying. Meats, especially tough meats, should be roasted a long time at a moderate degree of heat, 200° to 225° F. Tender meats and poultry may be roasted more quickly, at a heat not exceeding under any circumstances 320°, and if properly basted may be put upon the table with a very æsthetic brown upon the outside. Three hundred and twenty degrees F. is substantially the point at which the cracking or distillation of the fats begins, which is positively injurious. Simmering must be done at less than the boiling point. Stewing for the purpose of extracting all the juices of the meat without regard to the condition of what is left may be conducted at about the boiling point.

Upon the matter of baking bread I have not yet determined the very best point. One may take a sponge properly made and raised, put one-half of it into the common cooking stove or range, and bake it quickly in an hour to an hour and a quarter. The bread will be very light, very white and very tasteless, the finer flavors having been distilled and sent off in the pleasant smell of baking bread. Put the other half of the same sponge into the Aladdin oven at a moderate degree of heat, less than 250°, and bake it twice as long; you then have as light a loaf, of a rather creamy color, with a tender thick crust and with the full flavor of the grain. It will be thoroughly cooked, and persons of delicate digestion can eat freshly baked bread of this kind when they could not possibly eat freshly baked bread of any other kind without indigestion.

I have at home an oven made exclusively of glass, for what may be called fairly scientific purposes; and on Thanksgiving Day I baked a perfect loaf of bread in substance, color, fragrance and taste, — the full flavor of the grain. It was rather a small loaf, and it was baked two hours at 280°. From previous experience I believe that it would have been a little better at 250° or less; but there is a point at which we do not get the conversion of the outer crust into a brown color, which is due to the partial conversion of starch into grape sugar, an actual chemical change due to heat. At what point of temperature this formation of the true crust happens consistently with the full baking of the entire loaf I have not yet determined. I have roasted meats perfectly under these glass ovens, but made a partial failure on mince pie.

The difference between the Aladdin oven and these substitutes is that in the Aladdin oven there is no direct communication between the lamp and the food. The heat is carried in an interspace between the outer and the inner oven all around the latter. It is, therefore, nearly uniform. There is very little difference in the heat at the top and at the bottom, except immediately over the lamp, where some direct heat passes through the metal. We fend that off by introducing iron plates or a plate of soap-stone under the lower shelf. Therefore, if the lamp smokes, it must smoke very badly indeed in order to force its way through the door into the food receptacle, and a little deposit of soot on the outside of the inner oven does no harm. The inner oven can be removed at will, either to be cleaned outside or inside.

In these substitutes the heat passes directly through the hole in the metallic table into the space in which the cooking utensils are placed. I have invented a tube with orifices to put over the lamp under the tub or box, with a ring that can be turned so as to close the openings. But that ring cannot be made perfectly tight, and some smoke may force its way through the cracks. If the lamps are perfectly cared for they will not smoke, the danger of smoking being very little with the Bradley & Hubbard central duct lamp, and wholly avoidable with the flat wick duplex Trench burner.

In order to protect the food, except it be a roasting piece, it can be put into covered vessels. In that case, if the lamp smokes, it only puts a little soot upon the outside of the dish or covered pan.

It is almost inconceivable, to one who has not tried the experiment, what one can do in the way of fine cooking under an inverted half barrel. To be sure, it requires somewhat the same kind of attention as is required by stove cooking, but not as much. I will give you a little description of the kind of dinner party which I lately gave to some of my friends. There were twelve at the table, mostly incredulous ladies. I took charge of the whole matter myself, placed my various kinds of cooking apparatus around the walls of the dining room, and stayed at home to do some literary work, varying that work by preparing for the dinner party. My first undertaking was to serve what would have been a very ample dinner for the party of twelve, in five courses, at a cost for material of one dollar and fifty cents. This is a very simple and easy problem; and the dinner may be made equal to that which is served at Parker's or at any first-class restaurant by any person who has been taught to read. By that I do not mean reading as it is taught in many schools, — that is, reciting certain words from printed type; I mean any one who has been taught to read so as to comprehend the subject of the printed matter, — an art which is not, I fear, very apt to be found in our schools. This dinner consisted of a lentil vegetable soup, halibut nape *à la crême*, currie of veal with rice, stuffed fore-quarter of lamb roasted, bread and raisin pudding, apples or pears, tea or coffee. To that five-course dinner I added a hunter's lunch as it might be cooked in camp under a half barrel, which consisted of the following articles: four partridges, two grouse, baked apples and soda biscuit. I also cooked a very fine leg of Kentucky mutton in perfect manner under this sea-weed oven, and I also added various other examples of fancy dishes improvised for the occasion. The result was a conviction of mind such as is said to have been reported through a spiritual medium by an unbeliever who had gone from this earthly scene, and who sent back a message to his wife in the following terms: "Dear wife, I am convinced. Send me my thinnest clothes." It is because, according to my observation, the domestic kitchen, fitted with the infernal agency of the iron stove filled with hard coal under full blast, corresponds to the place in which this old gentleman wanted his thinnest clothes, that I have undertaken to substitute my methods for those which are now commonly practised.

I cautioned my friends not to consume the whole of the five-course dinner, but only to taste it, becoming assured that it would have sufficed had there been nothing else, so that they might test the finer examples or rather the examples of more expensive but no better food which followed. They were convinced. Their incredulity was wholly removed, as yours may perhaps be when we serve the contents of these various kinds of apparatus.

You will observe that I mentioned lentil soup. We have in one of these examples of food a type almost unknown in this country, and yet in respect to protein the most potent and the cheapest food in the world. It is in common use throughout the East and in the southern part of Europe. The lentil might be grown to any extent on waste lands in this country of very poor quality, serving not only for the nutrition of mankind but for animals, for fowls and for the nutrition of the soil; because it is one of the leguminous plants of the renovating order, which through bacteria draw their supplies of nitrogen from the unlimited sources of the atmosphere. When you have tasted a good lentil soup, you may cease to wonder that Esau sold his birthright for a mess of pottage, which the Scripture assures us was made from these same red lentils, of which I have a package here from a lot imported from Egypt.

In conclusion, let me observe that to one who is merely an economic student, and neither scientist, farmer, physiologist or chemist, the conditions affecting all these several departments of human welfare are in a sort of inchoate state. The elements of knowledge exist. Enough is known of the composition of soils, of the composition and source of fertilizers, and of the nutrition of the plant, the beast and the man, to give assurance that ere long all that we know will be brought into systematic form. From these various concepts and discoveries of science rules may be established that may be brought into common practice, so that the art which has heretofore been empirical in every department may be made consistent with the rules of science and may be developed in such simple, plain terms as to be brought within the comprehension of every person of ordinary intelligence.

I have brought with me some of our white and brown family bread, and in this jar I have an example of the kind of work of an experimental nature which can be done with a glass oven. I regret that I have no consecutive hours to devote to this matter except on holidays and Sundays. I sometimes consider the Sunday better spent in preparing a sermon upon the potato gospel than in listening to a sermon upon the spiritual gospel. I am justified in this by an aphorism invented by my friend Dr. William Everett for my benefit, corresponding to the old aphorism, "there can be no sound mind except in a sound body." Neither can there be any true spiritual life except in a well-fed body. "*Non est animus cui non est corpus.*" There is no soul unless the body eats, — not in this world, whatever may be the conditions in the next world, when we are supplied with wings and may perhaps do without stomachs. Therefore on Sunday I made a combination of white beans, tripe, tomato sauce, bacon, skimmed milk and one onion, seasoned with Hungarian or Paprika pepper and salt, while I devoted the morning hours to this treatise. This is a combination which requires very long, slow cooking; and I had it under the oven for eight hours, in which period I added a second supply of skimmed milk, to make up for evaporation. The heat within the oven, made of plate-glass quarter of an inch thick, was raised to 330–335° F., with one of these Bradley & Hubbard lamps. The heat on the outside, disclosed by a thermometer in contact, attained 135°, showing an accumulation within, due to the quarter-inch of glass, of 200° F. The cooking was very perfect, and the material has since been reduced to a pulp. I have not made an analysis of this combination, but in protein a pound would be equal to at least three pounds of clear beef. It cost at retail prices about seven cents a pound in a pasty condition after allowing for evaporation. On a large scale this compound could be made as a soup stock for about five cents a pound. If shin of beef were substituted for tripe, the cost would be much less. It would be very easy to add beef suet to supply fat, and thus make a merchantable compound to be packed in cans or jars, containing the exact proportion of protein and fat required for complete nutrition, with a given amount of starch to be added either in the form of bread or vegetables.

This compound corresponds in its general make to the German army sausage, in which the requisite proportion of starch is combined with the protein and fat. These sausages, like this compound, may be mixed with a certain quantity of water in a tin pan anywhere, warmed up, or even eaten cold. It will fully sustain a man in active work, either with bread supplying the starch separately from the compound, or with a certain proportion of starch combined. I think that this opens a field for new varieties of food to be put up either in cans or glass jars. The latter are much to be preferred, but are a little more expensive. Let me call your attention to the close analogy between my cooking apparatus and the best incubators.

The most complete application of my methods to the nutrition of large numbers of persons has been accomplished by President Booker T. Washington of the Tuskegee Institute, Alabama. He came to me with a plea to help him improve the nutrition of the colored students in a State where all the meats except hog products are stringy, tough and poor. He deemed a varied nutrition essential to the progress of his students. I advised him to construct an oven of pine plank, plastered on the inside with common mortar laid close to the plank on dove-tail lath; to make this oven of a section of about eighteen inches, as long as he pleased, and in the metallic bottom make a round hole two and one-half inches in diameter at every eighteen inches, under which to place a lamp; then to put large tin boxes or other receptacles for food in this oven, set up on legs an inch or so high, and with that to go on with the operation of cooking. Beginning in a small way, he has ended by building an oven of sufficient capacity to supply six hundred students with thoroughly well-cooked meats, bread and vegetables, the tough, stringy Southern beef coming out tender, appetizing and nutritious, without waste of the juices of the meat.

Now you have many problems connected with the feeding of beasts, of which I will only speak of one, — the right method of feeding wheat to stock. Two years ago I made a passage with a very intelligent London job master, who lets out a great many carriage horses, and who raises his own stock on his own farm. He was even then feeding wheat in preference to oats, the food value being greater pound for pound; but he said that, as wheat is naked or free of chaff and is liable to swell if fed raw, it must be soaked or parboiled and slightly cooked, in which condition it serves as a very valuable food for carriage horses, — cheaper than oats, — with a good proportion of hay or other more bulky food. By the way, why do Englishmen keep hay two years before feeding?

I believe it is an open question whether or not to cook food for many kinds of animals. Suffice it that where it is expedient to cook food an apparatus corresponding to that which has been set up by President Washington at Tuskegee may serve for the preparation of large quantities of slowly or slightly cooked grain or combinations of grain and chaff. I will give you a caution that there is a remote danger of carbonizing the wood in a long period; therefore such apparatus should be kept separate from other buildings, or else it should be placed on a stone or dirt floor, where, even if the outer shell should take fire, it may do no harm. This danger is very remote.

I have attempted but one combination which was a purely theoretic one, but it has proved to be excellent in practice. It occurred to me that if I combined a certain proportion of the meanest kind of chaff from the corn mill, the little nubs which are called smuttings, — sold, I believe, at five dollars a ton when sold at all, — with skimmed milk, a little crushed oyster shell and a little suet, I might make a food for hens corresponding in its chief elements of nutrition to the best wheat bread with a little fat and lime added. I made this combination, and cooked it slowly all night. I sent my receipt to my friend Mr. J. Montgomery Sears, who is a very successful supervisor of his own farms, and he adopted it, finding it a most excellent food for hens, which could be provided at a very low cost.

I trust that this summary of my observations may not be without interest to you, and perhaps be of some service in the progress of agriculture.

After the lecture ended, the contents of three types of Mr. Atkinson's apparatus were distributed. In the standard Aladdin oven a combination of food had been prepared corresponding to a four-course dinner for an ordinary household of ten persons, rather more than ample. Soup, having been prepared beforehand and warmed, made the fifth course. Seven different combinations of food material were distributed, which had been cooked under a box made of pine wood lined with tin, hinged on one end so as to be readily turned upward for service. These examples had been cooked in various types of earthen jars. Other different examples of roasting, baking and broiling were distributed from an inverted box made of seaweed and brown paper, quilted, and protected on the inside by binder's board.

The food served as an example of the Aladdin methods of cooking was as follows : —

Lentil soup, . . .	$0 15
Roast lamb, . . .	1 17
Halibut *à la crême*, . .	25
Corn meal and sausage, .	15
Ham, ...	1 44
Roast chicken, . . .	58
Baked beans, . . .	14
Apple pies, . . .	20
Apple-sauce, . . .	10
Potatoes, ...	10
Oatmeal, ...	4
Macaroni, . . .	15
Bread and raisin pudding,	15
Beef stew, . . .	10
Almonds, ...	10
Biscuit, ...	10
	$4 92

About one gallon of oil was consumed under the three ovens in the preparation of this material. Average value for a fine grade of oil, ten cents.

SECOND DAY.

The meeting was called to order by Secretary **Sessions** at 10 o'clock, who said: A little preliminary skirmishing before the battle will clear the air, perhaps. Professor Maynard is in the audience, and I wish he would come forward and tell us what he has on exhibition below.

Prof. S. T. **Maynard** (of Amherst). Gentlemen, the matter of protecting our fruit crops from attacks of insects is one that is attracting a great deal of attention throughout the country, and to illustrate the methods of using insecticides and fungicides, we have on exhibition some of the pumps used for that purpose. We have a machine pump and barrel pump, and I will have upon the stage some of the smaller pumps, the knapsack pump; and some of the others are in the room below, where they can be seen as you are passing by. The apple crop has been very large, and perhaps one-third of the crop has been wasted and gone to decay. In order to prevent this, we have been making some experiments with the use of evaporators for drying at the Agricultural College, using waste apples, the drops and seconds, and even the cider apples. I have some products from the evaporators in the room below, which may be seen by you. We were not able to get the evaporators into this room, but someone will be there during the intermissions to explain downstairs.

Secretary SESSIONS. I have now the honor to turn over the meeting to Mr. GRINNELL, the first vice-president of the Board.

Vice-president GRINNELL then took the chair.

The CHAIRMAN. Our subject, this morning, as you know by the programme, is "How to keep up the fertility of our farms," by Prof. William P. Brooks, professor of Agriculture in the Massachusetts Agricultural College. Our friend Mr. Wood, who is so well known to you all, will preside at this meeting. Mr. Wood needs no introduction to the members of the State Board of Agriculture and the fruit growers of Massachusetts.

Mr. E. W. WOOD (of West Newton) then took the chair and said: The subject selected for this forenoon's discussion is perhaps of as much practical importance as any that could be brought before you, — the matter of fertilizing the soil to produce your crops. When you consider the amount of money you invest in those fertilizers, added to the cost of manual labor in producing the crop, you often find that the margin of profit left is very narrow; consequently you will see the importance of finding the best and the cheapest fertilizer to be used to produce these results. The committee was fortunate in being able to secure the lecturer, who has had an opportunity to make careful experiments extended over a considerable length of time, and who will give you those results in a manner which will make them easy of comprehension. The subject has already been announced by the vice-president, and it gives me pleasure to introduce to this audience Professor Brooks of the Agricultural College.

Prof. WILLIAM P. BROOKS (of Amherst). Mr. Chairman, ladies and gentlemen: I thank you, Mr. Chairman, for your very kind introduction, and the audience for their kind response. I do not know but you feel better-natured towards me now than you will when I get through, because I am almost afraid that I shall wear you out. You need not be appalled, however, at the formidable array of figures that I have spread before you. I do not expect you will learn them all.

HOW TO KEEP UP THE FERTILITY OF OUR FARMS.

BY PROF. WM. P. BROOKS OF AMHERST.

The subject assigned to me is one of the utmost importance, and, like most subjects of that nature, it is an extremely comprehensive one. Its full and exhaustive discussion within the limits of a popular address of such length as this occasion permits is an impossibility. At best I can but give in outline a general statement of my views upon this subject, and this I undertake in the hope that it may provoke thought and discussion, and not with the idea that I can or should attempt to tell you exactly what to apply to your individual fields.

Well known as the ordinary significance of the word fertility is, it seems desirable to call attention at the outset to the fact that the conditions contributing to make our lands productive are numerous. It is generally understood that the physical or mechanical conditions of the soil, or, to be more precise, its texture, the proportion of fine and coarse particles, its drainage, its capacity to hold capillary water and to favor the rise of water from below, and its relations with heat, have quite as much to do with its productiveness as its chemical composition. Interesting and important as a discussion of such matters might be made, I believe that it was not contemplated by your honorable secretary in selecting this subject; and accordingly, though I cannot forbear calling your attention to some of the results of the physical analyses of a few typical soils, I shall confine myself chiefly to the consideration of manures and fertilizers in their relations to the important question of how to keep up fertility. It should be remarked, however, in passing, that even these contribute to fertility in many instances by improving the physical condition of the soil. Still, I shall be obliged to confine my attention for the most part to a consideration of the use of these materials in their relations to the composition of soils and crops; or, in other words, I shall consider the subject chiefly in its chemical and not in its physical relations.

Before entering upon the discussion of this part of my subject, I desire to illustrate, by calling attention to the results of the physical analyses of a few soils, the intimate relation of physical conditions to fertility. The method of analysis followed in obtaining these results, for which I am indebted to Prof. Chas. Wellington, is that proposed by Prof. E. W. Hilgard of California. The object aimed at is to separate the soil into a number of different grades, according to fineness, and in accomplishing this result water is used. According to Hilgard's system, the soil from which all stones and pebbles are first removed is divided into thirteen different grades, respectively denominated coarse, and fine grits; coarse, medium, fine and finest sands; dust; coarsest, coarse, medium, fine and finest silt; and clay.

The soils selected for this illustration are the Agawam "plain" land, which is of a very low grade of fertility, and on which crops suffer very seriously in dry weather; the soil of the Hatch Experiment Station grounds at Amherst, which is fertile and of nearly ideal physical character; and the soil of the diked salt marsh of Marshfield, which is heavy, and becomes wet and sodden in wet seasons, and bakes and cracks during drought.

	Agawam Plain (per Cent).	Hatch Experiment Station (per Cent).	Diked Marsh (per Cent).
Coarse grits,	2.57	–	–
Fine grits,	13.71	2.26	–
Coarse sand,	7.43	1.48	.60
Medium sand,	1.65	.20	1.50
Fine sand,	3.54	.40	–

	Agawam Plain (per Cent).	Hatch Experiment Station (per Cent).	Diked Marsh (per Cent).
Finest sand, ...	17.00	2.70	1.55
Dust, ...	7.31	30.34	2.08
Coarsest silt, ...	16.41	4.70	5.90
Coarse silt, ...	14.42	25.80	13.91
Medium silt, ...	1.59	5.14	8.60
Fine silt, ...	9.04	19.11	50.48
Finest silt, ...	–	–	–
Clay, ...	4.89	6.70	13.80
	98.83	99.56	98.47
Finest sand or coarser, . .	45.90	7.04	3.65
Dust or finer, ...	53.66	91.79	94.77

The significance of these figures is made more strikingly evident by massing them somewhat. We find by addition that the percentages of materials of the grade of finest sand or coarser are as follows: Agawam, 45.90; Hatch, 7.04; marsh, 3.65; of the grade of dust or finer, Agawam, 53.66; Hatch, 91.79; marsh, 94.77.

In the soil of the Hatch Experiment Station we have that fortunate blending of materials which secures conditions favorable to agricultural operations; while the other soils represent two opposite extremes. The Agawam soil has too large a proportion of coarse, the diked marsh too large a proportion of fine, material.

The soil from the Hatch station is one to which it will be found profitable to make large applications of manure or fertilizers, because the physical conditions are such as to allow them to exert their maximum effect. Upon soil of either of the classes represented by the others under consideration the farmer must exercise greater caution, because with unfavorable seasons the results are certain to be poor.

And this leads me to say at this point that, while the farmer cannot change, except within narrow limits, the relative proportion of coarse and fine materials in his soil, he can, by intelligent, thorough and careful culture, do much to insure profitable returns from his use of manures and fertilizers. It is folly to lavish these while withholding the work necessary to insure fine tilth both before planting the seed and during the growth of the crop.

Let it be understood, then, at the outset, that one of the most important methods of keeping up the fertility of the soil is by thorough preparation and careful culture. Not only do these insure such physical conditions that manures and fertilizers applied will do their best, they also favor the action of the beneficial natural agencies which are constantly at work under favorable conditions converting the raw materials of the soil into available food for plants. The great importance of this action becomes evident when we consider the chemical composition of the soil.

At this point it is necessary to say that, in considering the composition of soils, plants, manures and fertilizers, I shall confine my attention to the three constituents, — nitrogen, phosphoric acid and potash. It is well known that all contain numerous other constituents, such as lime, magnesia, soda, silica, etc.; but, it being generally admitted that the natural supply of these is so liberal that our crops rarely suffer because of a deficiency of any of them, it seems best to leave them out of consideration, inasmuch as a thoroughly satisfactory treatment of our subject even thus restricted is an impossibility in the time available.

In connection with experimental work carried on under my direction during the last six years and in preparation for the Columbian Exposition I have had a considerable number of soils from different parts of this State and of different geological characters subjected to analysis. The partial results of some of this work I desire to bring to your attention, not in percentages as reported from the laboratory, but worked out in pounds per acre, in which form their significance becomes much more apparent; and for comparison therewith I present similar details for a few prominent field crops. These figures I shall have occasion to use later also in considering the application of manures and fertilizers.

PARTIAL COMPOSITION OF SOILS AND CROPS.

Soils to the Depth of One Foot.

	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).
Yarmouth, one acre, . .	5,950	3,500	1,050
Freetown, one acre, . .	5,950	3,500	700
Hadley, one acre, . . .	7,700	5,250	1,750
Amherst, one acre, ten inches,	6,356	8,611	10,556
Agawam, one acre, six inches,	1,295	1,667	3,000
Marshfield, one acre, twelve inches, ...	15,322	5,600	5,600

Crops.

	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).
Corn, 100 bushels, and stover, 3 tons, ...	163	57.6	107
Potatoes, 300 bushels, . .	37	12	53
Timothy hay, 4 tons, . .	101	37	122
Clover hay, 4 tons, . . .	178	36	183

The point to which I now desire to call particular attention is the fact made evident by these figures, that, as compared with the amounts removed by even very large crops, the soil contains an enormous supply of the prominent constituents of plants. Even the poorest of the soils under consideration, the Agawam "plain" land, contains as much nitrogen in the upper six inches as eight enormous crops of corn, as much phosphoric acid as twenty-nine such crops, and as much potash as twenty-eight such crops. Of course we all know that most of this plant food must be in unavailable forms; for this Agawam "plain" land will not produce even one good crop of corn without manure or fertilizer. We also know that our crops cannot "lick the platter clean," or, in other words, that *in order that they may obtain what they need there must be much more than they will take up at hand.*

It does, however, impress me strongly that, since there exist, even in the poorest soils, such enormous stores of inert plant food, it does behoove us as farmers to so manage our lands as to favor in all possible ways its conversion into available forms. You have doubtless all heard or read of the famous Englishman, Jethro Tull, who by thorough and frequent working of the soil to a good depth raised better crops of wheat for many successive years upon the same land without manure than his neighbors did with it. Tull followed laborious and painstaking methods of hand work with the spade, — methods clearly not adapted to present economical conditions; but whatever the method followed, work upon the soil costs, and it becomes, therefore, an important question to decide as to how far it will pay to attempt to substitute tillage for manures, — a question, however, which must be left to individual determination. Thorough drainage, fall ploughing, complete aeration and pulverization of the soil before and during the growing season are, however, means of keeping up fertility which often receive too little attention.

DIFFERENCE BETWEEN NITROGEN AND PHOSPHORIC ACID AND POTASH.

Before taking up the question of the selection and application of manures and fertilizers with a view to increasing or keeping up the fertility of our soils, it is important to understand the wide difference in the extent to which soils are capable of retaining nitrogen on the one hand, and phosphoric acid and potash on the other. We are indebted largely to the careful and long-continued study of the drainage waters of the experimental acres at Rothamstead for the knowledge that soils have very little capacity to hold the former in its soluble compounds, such as nitric acid and ammonia; while under ordinary conditions they hold very tenaciously both phosphoric acid and potash, whatever the forms in which they may be applied. This important difference must be kept in mind in deciding to how great an extent it is desirable to endeavor to increase the store of food in the soil. It is evident that we may safely direct our practice toward this end, in so far as phosphoric acid and potash are concerned, for the bank which holds these is "solid," and a working capital is desirable; but with nitrogen we must clearly pursue a different plan. Soluble nitrogen fertilizers applied one season in excess of the requirements of the crop are likely to be lost in the drainage waters of the soil before another crop is planted. To endeavor to accumulate a working nitrogen capital by the application of soluble materials such as nitrate of soda is folly; but such capital is desirable, and its accumulation in the various organic substances, such as manures, stubble and roots of grass and clover, green crops to be ploughed under, etc., is sound practice.

Green Manuring.

What part, if any, green manuring should occupy in farm practice, is a question which many are now asking; and, as it is a question of chief importance in its relations to the soil nitrogen, it may well be briefly noticed in this connection. It should be understood, first, that green manuring cannot increase the total of either phosphoric acid or potash in the soil. Whatever of these elements the plant grown as a green manure may contain was taken from the soil; it can come from no other source, and it is simply returned thereto. Neither is the growth of a green crop of any great importance in preventing loss of phosphoric acid or potash by drainage; for, as I have pointed out, the *soil* has the capacity to retain these. Must we then conclude that green manuring is of no benefit in so far as the elements under consideration are concerned? My answer is, no. The feeding roots of all plants are provided with an acid which enables them to exert a powerful solvent action upon the particles of the soil with which they come in contact. The crops suited for green manuring are all especially vigorous growers. Their myriad roots ramify throughout the soil, dissolving phosphoric acid and potash as they go. These constituents enter into the plant, and when this is turned under to decay they become available to the succeeding crops, — more available than are the phosphoric acid and potash, still a part of the mineral particles of the soil. Whatever has once been a part of a plant is in condition the more readily to become so again. Thus it will be seen the practice of green manuring ultimately increases the availability of the natural stores of phosphoric acid and potash of the soil.

As regards nitrogen, green manuring may serve two important purposes: it may be made, first, a means of conserving soluble soil nitrogen; and second, a means of gathering nitrogen from the air and making it a part of the soil capital.

Nitrogen Conservation.

The first of these two effects — nitrogen conservation — is hardly second in importance to the other. In some of the forms in which nitrogen is applied to the soil, *e.g.*, nitrate of soda, it is at once liable to loss by leaching downwards; in most of the other forms in which it is supplied it soon enters into soluble combinations, and becomes liable to such loss. How to prevent this loss is a question of the first importance. We may not be able to do this altogether; but the most effectual means appears to be to keep the soil full of the hungry roots of a growing crop. Wherever the soil is unoccupied, especially in the late summer or autumn, with heavy rains there will be a loss of the soluble nitrogen of the soil which has been accumulating during the warm, dry summer weather, — a loss which could not occur were the soil occupied with a growing crop, for the roots of such a crop would seize upon the soluble nitrogen as fast as produced, it would become a part of the plant, an insoluble part, not again to become soluble until the processes of decay shall break down the new vegetable tissues. Green manuring, then, enables the farmer to conserve soil nitrogen. It enables him to adopt a simile, to put the soluble nitrates which his effective handmaids warmth, air and bacteria have been producing under lock and key, and to hold them there during the period (autumn, winter and early spring) when that active thief, heavy rain, is most likely to abscond with them.

My meaning will be clearer if I give an illustration. Indian corn has usually practically finished its growth by the middle of September. It is a crop to which considerable manure is applied, and the nitrogen of this manure is gradually rendered soluble (converted into nitrates) by the agencies at work in the soil during the summer and fall. So long as the corn is growing, its roots stand ready to take these nitrates; but these roots become inactive at the very time when the rains ordinarily become more abundant; and between this time and winter there are two months during which we are very likely to lose nitrates by leaching. To prevent this loss, a hardy crop may be sown in the corn, one which will grow until cold weather actually sets in, and the roots of this crop will take up the nitrates. For this purpose I have used white mustard, sown about the first of August. It usually continues to grow until the middle of November. Winter rye may be used for the same purpose, provided the land is not to be planted before the end of May in the following year.

On many farms land is allowed to lie bare for weeks after such crops as early potatoes or rye. This is a bad practice. Something should be kept growing. The disadvantages of allowing weeds to take possession are well known. Plough, or harrow and sow on some cheap, quick-growing seed, to "police" the field, keeping down marauding weeds and preventing the theft of nitrates. As an important means of keeping up the fertility of our farms, I would insist, then, upon the great utility of keeping something (not noxious) always growing in our fields. Whether we should turn under in its entirety the crop grown, or utilize it as a feed, is a point which I shall take up later.

At the college farm I have had one acre of land under an experiment, designed to show the exact results of green manuring. The results are not yet very striking; but this year for the first time, after three years' continuation of experiments, the crop on that part of the field which has been green manured is considerably larger than it is on the other.

NITROGEN GATHERING.

We have heard a great deal of late concerning the importance to the farmer of the more extensive cultivation of crops belonging to what the botanists know as the natural order *Leguminosæ*, among the more important members of which are clovers, peas, beans, vetches and lupines, because of the ability they have to take most of the nitrogen they require from the air. So far as we now know, none of our other important field crops are able to do this. When we remember that nitrogen is the most costly of all the constituents of fertilizers, — usually commanding from fourteen to eighteen cents per pound, — and that the supply of this element in the air, four-fifths of which is nitrogen, is exhaustless, we are able to appreciate the importance of this peculiarity of the members of the clover family. Time will not allow us to go into details; suffice it to say that, through the agency of bacteria which develop in little nodules upon their roots, the clovers and their relatives are undoubtedly able to assimilate atmospheric nitrogen. How shall the farmer derive a benefit from this knowledge? Clearly by the more extensive culture of such crops as have this capacity. But this must be done under appropriate conditions, or he will fail to reap the expected advantages. Briefly, the more important of these conditions are: first, well-drained and well-pulverized soil; second, a liberal supply of the mineral elements of plant food, such as phosphoric acid, potash and lime; third, the presence of the germs of the proper bacteria; and fourth, only a small stock of available soil nitrogen. Only the third and fourth of these, I think, require explanation. The nodules on the roots are the result of the growth of certain microscopic plants (bacteria) in the roots. In the absence of these bacteria the plant is powerless to make use of atmospheric nitrogen. The bacteria which develop on the roots of different plants are distinct and different species, they develop from germs or spores. Clover nodule bacteria come from spores of that bacterium; they can not come from the bean nodule bacteria any more than clover seed can grow from beans. Practically and fortunately, clover nodule bacteria are probably found in all soils, because clover has been so long cultivated that they have become everywhere disseminated. The same is true of the bacteria developing in the roots of common beans and peas. This is not likely to be the case with the bacteria developing upon the roots of such crops as are new in any particular locality. Thus, for example, the soya bean upon the grounds of the Storrs School experiment station was a failure — clearly being unable to appropriate nitrogen from the air — until the appropriate bacteria were procured from Amherst, when a seemingly magical change was produced. Attention is called to this fact to emphasize this point: farmers should not be too easily discouraged in their trials of new leguminous crops; they may succeed poorly at first, on account of the comparatively small number of their nodular bacteria present; but may later prove profitable when these bacteria become abundant, as they generally will in the course of a few years.

I knew nothing about these bacteria when I brought the soya bean from Japan, but most fortunately I brought some dust that got on the beans when they were being threshed, and I evidently brought the bacteria, because I had plenty of them after a few years in the soil at Amherst. While I do not know the history of Professor Phelps' soya bean, he was unfortunate, evidently, in the first place, in not getting the bacteria with the seed. I say this because, if you do not have very good success in growing leguminous crops in the first few years, you should not become discouraged, because in a few years the bacteria will become abundant. They have great reproducing power.

As a fourth condition to the profitable utilization of the leguminous crops, I have indicated that they should be grown on soils containing but a small amount of available nitrogen. It appears to be a fact that when there is a sufficiency of available nitrogen in the soil, they make little use of that from the air. They can apparently secure the necessary nitrogen from an available store in the soil at less expense of energy than is required to take it from the air; and, if you will allow the expression, they appear to be lazy, like the rest of us, and will not take two steps to get what is at hand after one. We must grow leguminous crops, then, in soils poor in available nitrogen, and should not apply nitrogenous fertilizers to them in any considerable amounts. Beyond a supply sufficient to give these crops a start, nitrogen placed before legumes is practically thrown away.

The withdrawal of nitrogen from the air through the agency of the legumes may be made an important factor in the maintenance of the fertility of our farms. This is true whether we plough under such crops, or feed them, carefully saving and applying the resulting manure; and I regard the latter plan as generally preferable. Every crop we grow has two values, — a food value and a manurial value. Plough the crop in, and we get the entire manurial value. Feed it wisely, we get the full food value, and besides, in the excreta, four-fifths of the manurial value. Food value plus four-fifths the manurial value minus the cost of handling crop and manure under conditions prevailing in Massachusetts will generally be greater than the full manurial value; hence the wisdom of feeding rather than turning under a crop which farm stock will relish. There are of course, exceptions; but as a general rule I would pasture or cut and feed green crops grown either for nitrogen conservation or as nitrogen gatherers.

It should be remembered also, that the manurial effect of the roots and stubble of a green crop is always considerable. In the case of red clover it has been found that we may under favorable conditions cut and carry off hay crops which may contain two hundred pounds of nitrogen, and still there will be more nitrogen in the surface soil (including clover roots and stubble) than was present before the clover was planted. This seems very much like "eating one's cake and having it too."

MANURES.

In taking up that part of my subject dealing more particularly with the use of manures and fertilizers as agents for the maintenance of soil fertility, — on the whole by far the most important part, — it seems appropriate to speak first of manures, as these constitute a home resource upon most of our farms. As farmers I have no doubt you all appreciate at their full value the various forms of manure, and it may seem in a measure unnecessary to spend valuable time in considering them; yet, in the hope that my remarks may set some of you to thinking and experimenting, and at the risk of bringing "coals to Newcastle," I propose to offer a few suggestions and remarks upon the saving, handling and use of manures.

We sometimes read and hear language which would lead one to think that in the minds of some there exists a notion that there is something of a conflict between manures and fertilizers. This is far from my idea upon this question, and I doubt not most of you will agree with me. It is clearly the part of wisdom first to make the utmost of home resources. There may be crops or there may be soils or fields for which under certain circumstances it is preferable to use fertilizers rather than manures; and of course when one must purchase the elements of fertility it is an important question whether they can be more cheaply obtained in manure or fertilizer, and I believe the decision must usually be in favor of the latter, as I shall presently show; but these facts really indicate no necessary conflict between the two classes of materials. There is clearly room enough for both. With an average of only about one ton of hay, thirty-two bushels of corn and about one hundred bushels of potatoes per acre in this State, in face of easily possible yields of three tons, seventy-five bushels and two hundred and fifty bushels respectively, it will not be denied that there is place enough for both manures and fertilizers.

In the remarks that follow I shall deal principally with manure made from cattle, chiefly milch cows; and I shall refer to this as farm-yard manure, as I think is the usual custom. The manure from horses I shall refer to as stable manure; that from sheep and hogs will not be specially referred to.

MANURE MORE COMPLETE THAN FERTILIZER.

At the outset it must be pointed out that manures are more complex in their composition than fertilizers. They contain all the elements found in plants, while fertilizers as a rule do not. Besides the nitrogen, phosphoric acid and potash, manures, as has been stated, contain lime, magnesia, soda, silica, chlorine, sulphur, iron, etc. Whether this fact does not render the manure more valuable for continuous use is a question to which I shall later recur.

The value of manures varies with numerous conditions, most important among which are the nature of the food of the animals from which it is made, and the method of handling and saving. To illustrate these points, I wish to call your attention to a few analytical results.

Composition of Manure.

LOCALITY.	Water (per Cent).	Nitrogen (per Cent).	Phosphoric Acid (per Cent).	Potash (per Cent).	POUNDS PER TON.		
					Nitrate.	Phosphoric Acid.	Potash.
Amherst (average), .	65.9	.454	.333	.569	9.1	6.7	11.2
Hadley, . . .	50.6	1.230	.740	1.400	25.6	14.8	28.0
Westfield, . . .	78.8	.398	.193	.168	7.9	3.9	3.3
Concord, . . .	55.2	.290	.211	.346	5.8	4.2	6.9
Worcester, . .	69.8	.206	.102	.132	4.1	2.0	2.6
Average of thirty-eight samples, .	67.3	.477	.32	.41	9.2	6.2	9.8
Liquid manure, . .	96.25	.98	.24	.88	19.6	4.8	17.6

It will be noticed that farm-yard manure on the average contains about one-half of one per cent of nitrogen, one-third of one per cent of phosphoric acid, and four-tenths of one per cent of potash. A ton of such manure therefore will supply about nine pounds of nitrogen, nearly five pounds of phosphoric acid and about eight pounds of potash. A cord of farm-yard manure weighs upon the average about three tons. The plant food supplied in one cord is, therefore, about as follows: nitrogen, twenty-seven pounds; phosphoric acid, fifteen pounds; and potash, twenty-four pounds. A common two-horse cart-load weighs usually just about one ton. It will be observed, however, that the analyses vary widely; a few are much better than the average, generally because they are drier, while a number are much poorer particularly in nitrogen and potash. This inferiority may in part be due to differences in feed; but I believe it is in a greater degree the result of imperfect methods of saving and handling.

The figures marked "Amherst" are the average results of the analyses of twelve samples of cellar manure made from the college herd of milch cows. The cellar was well drained, so that there was no foreign water, and the bottom was cemented and the walls pointed, so that there could have been little or no loss of liquid. It will be noticed that the most important difference between this and the average of all the manures is a considerably larger percentage of potash. This difference we can readily understand, when we know that a large part (usually about four-fifths) of the total potash excreted by animals is in the urine, which, under conditions existing on many farms, is allowed in part to run to waste. The results of the analyses of the liquid from the gutter in a cow stable afford evidence of this. This liquid, though ninety-three per cent water, contains more than twice as much potash as average farm-yard manure. The same results enable us also to understand in part why so many manures are poor in nitrogen. It will be noticed that this liquid manure contains more than twice as high a percentage of this element as average manure. It is well known that manures suffer loss of nitrogen also through the escape of ammonia into the air when it is allowed to heat in loose piles. We cannot, therefore, wonder that they are frequently very poor in this element.

My remarks make sufficiently evident, perhaps, the precautions necessary to prevent unnecessary loss in the manure pile. They must be such as to prevent loss of urine, leaching and rapid fermentation or heating. The first two of these conditions are secured in a perfectly drained and water-tight cellar for the accumulating manure, and the third by keeping hogs thereon. These animals will keep the pile so compactly trodden that it will not heat rapidly. Of course the liberal use of absorbents, such as dry earth or muck, sawdust, plaster or kainit, may be made to contribute to the desired result.

So far as the amount of labor and the preservation of the valuable elements in the manure are concerned, this plan, still by far the most common in this State, leaves little to be desired. But its effect upon the health of the cows in the stable above and upon the hogs in the cellar itself are such as to lead me to condemn it, at least if the cellar is closed on all sides. The bad consequences of this system can be much lessened by the liberal use of absorbents and chemicals, such as plaster and kainit, both in the stable and in the cellar, and by the frequent removal of accumulated manure.

My preference, however, is to keep cattle in a wing connected with the hay barn, and without a cellar underneath. The floor should be tight, and the drainage from the gutter behind the cattle should be conducted to a water-tight cistern outside. An excavation at the outer end of this wing will permit the backing up of a cart or manure spreader on such a level that the manure can be dumped directly into it from a barrow or overhead trolley car. This plan would doubtless prove inconvenient where only a small herd is kept, and sometimes impracticable upon a large place. For these reasons I should prefer to provide a shallow, cemented basin, protected by a shed roof, so that the manure might be allowed to accumulate for a few weeks, if desired. When the herd is large, however, the labor of handling manure — and it is this item that makes it cost — can be reduced to the lowest point by the plan of dumping into a cart or manure spreader, and then applying directly to the field.

And this leads me to say that I believe most fully in the plan of applying manure to the fields as fast as made, in so far as this course is practicable. It is difficult to keep it without loss, or injury to the health of our stock. I would generally fall-plough the fields to be manured, and then during the fall and winter months get out and spread the manure as made. The experience and observation of many practical men has convinced them that this is the best plan. Under this system the soluble constituents of the manure are washed directly into the soil; and ammonia is not formed with such rapidity as to be driven into the air in any considerable amount. The manure as it lies upon the surface does not heat, it can hold considerable ammonia, and every rain or melting snow dissolves and carries into the soil what has been formed. It is clearly advisable to apply during the winter to the more level fields; but even on those with considerable slope, if ploughed across the slope in the fall, there will be little wash. The dressing of manure will help to prevent it, as well as to protect soils of the lighter class from the loss of fine particles by the action of wind.

The portion remaining upon the surface in spring has lost most of its virtue, and it may either be worked in with the harrow or ploughed in, as circumstances render advisable. It should perhaps be pointed out that a heavy application of manure while the soil is frozen will hinder the coming out of the frost in spring, so that it may be inexpedient to follow this plan where early garden crops are to be raised.

The plan of hauling out manure during winter and early spring, and putting into large heaps, to be forked over and later spread, has little to recommend it for the common farmer. It of course improves the mechanical condition of the manure, but it involves much labor, and the pile under ordinary conditions is subject to loss through leaching and fermentation. Let any farmer who has been accustomed to follow this practice try the plan I recommend, and I believe he will become convinced of its superiority.

Use Manure and Fertilizer Together.

Upon most of our farms the supply of manure is insufficient. The majority of farmers use some fertilizer. It is generally wise for the ordinary crops of the farm to use these in connection with each other, rather than separately. The physical effect of the manure is generally desirable, and cannot be obtained by the use of fertilizers. It prevents in a measure the cohesion of the particles in heavy clay, and thus lessens the probability of baking and cracking, and it seems to increase the capacity of the lighter soils for moisture. The constituents of manure are also in many cases less promptly available than in fertilizers. It is desirable to employ the latter to give the crop a quick start. And, finally, the manure is more complete in its composition than the fertilizer. The manure replaces at least in part the soda, magnesia, silica, etc., removed in crops, while most fertilizers do not.

We may, it is true, raise crops for many years by supplying the three elements nitrogen, phosphoric acid and potash (incidentally lime is applied with the phospate). Lawes and Gilbert have raised wheat fifty consecutive years on the same land on ammonia salts, superphosphate and sulphate of potash; and at the present time the yield is nearly as great on this land as on that which has received fourteen tons yearly of farm-yard manure for the same length of time; but the yield on the fertilizers now begins to show a tendency to fall of, and there can be no doubt that the more complete composition of the manure is proving an advantage. Of course in such materials as common salt, sulphate of magnesia, etc., we may replace, if considered desirable, the soda, magnesia, etc., carried off in the crops; but even such replacement would leave us without the physical effect of manure, — an effect which we may, it is true, in part secure by turning in a green crop. Under many systems of cropping, however, green manuring is inexpedient. You cannot afford to give up the land for it. You have got to keep the land producing something you can sell.

For potatoes, because this crop is generally cleaner and freer from disease on fertilizer only, I would make an exception to the general rule; and I should also except most of the crops involving much hand labor, such as onions, because there are less weeds where fertilizer alone is applied. In the case of a field lying at a great distance from the barns, there is also an evident saving in depending upon fertilizers alone.

FERTILIZERS.

Having thus stated in outline my ideas as to the saving, handling and application of manures, we may take up the consideration of fertilizers as a means of keeping up soil fertility. Under this general name are included a very large number of materials of very diverse characters. You will not expect me to take up each in detail; here, as with other parts of my subject, I can deal only in outline. It will be an advantage to adopt some classification of fertilizers, and for my present purpose, though not strictly scientific, I shall speak of them under the following heads: phosphates, special complete fertilizers, and raw materials or chemicals;

and the latter will be subdivided under three heads, according to the leading element furnished, viz., nitrogenous, phosphatic and potassic materials.

Phosphates generally called for by Buyers.

I have little doubt many of you, when thinking of purchasing a fertilizer, still from force of habit feel inclined to call for a phosphate or superphosphate. This is perhaps natural, for the superphosphate was the first manufactured commercial fertilizer, and for many years the only one; and this is my reason for having taken as my general head the term "phosphates." Superphosphate, when first made, was a definite article manufactured from bones. It supplied phosphoric acid and a little nitrogen. Now the term "phosphate" means almost anything. Little by little, as chemistry shed its light upon the subject, and the wider needs of plants became understood, phosphates were amended or improved by the addition of now one ingredient, now another. To-day a phosphate may be a material furnishing phosphoric acid alone; it may furnish either nitrogen or potash in addition, or it may furnish both these with the acid. Of course the guarantee of composition enables the farmer to learn, if he will, what he is buying; but I regard it as an unfortunate state of affairs that a term such as "phosphate" should not have a more definite meaning. At present, if one desires to purchase a material furnishing phosphoric acid alone in available form, he must use such terms as acid phosphate, plain superphosphate, dissolved bone-black, etc.

Special Fertilizers.

A special fertilizer is one claiming to furnish the nitrogen, phosphoric acid and potash in the best proportions and in the best combinations for some particular crop or a few somewhat allied crops. Thus we have special corn fertilizers, potato fertilizers, onion fertilizers, tobacco fertilizers, etc.; and of most of these we may find a considerable number of brands upon the market. Most of you are aware that Prof. Levi Stockbridge was the pioneer in introducing this system of fertilization; and you are equally aware that he has had numerous imitators. This system undoubtedly constituted a distinct advance in the the practice of feeding our crops. It was a commendable effort to adapt the food to the appetite of the plant. In so far as the system is based on the composition of the crop to be produced, it cannot be regarded as wholly scientific. The soil as well as the crop should be considered. The soil contributes to the food of the plant, and soils naturally vary. The peculiarities of the crop should also be taken into account. Plants differ widely in their ability to forage for themselves. Some are like Devon or Ayrshire cows, — able to fatten on scanty pasturage; others are like Shorthorns, who require abundance of rich feed at hand. Thus the potato, for example, is a poor feeder. Indian corn is a far better forager. The season during which the plant makes its chief growth also affects the necessity of supplying the different elements of food, particularly the nitrogen. The grass crop, for example, does not withdraw from the soil an exceptionally large supply of nitrogen. In four tons of English hay there are 113 pounds; in 100 bushels of corn and three tons of stover there are 163 pounds; yet for the grass it is best to apply considerable nitrogen in available form in early spring, while for corn a large application of available nitrogen is not generally required.

Increases in Crops on One Acre, Six Years, — 1889–94.

YEAR.	CROP.	N.	P. A.	Pot.	N. and P. A.	N. and Pot.	P. A. and Pot.	N., P. A. and Pot.	Manure.*
1889, . .	Corn, bushels, . . .	6.3	5.1	26	2.5	19.6	24.9	30.7	22.3
	Stover, pounds, . .	220	500	1,540	20	930	1,870	2,080	2,120
1890, . .	Corn, bushels, . . .	—.2	6	19.5	8.3	8.7	18.1	23.6	25.4
	Stover, pounds, . .	—1,100	—1,260	1,900	130	973	1,487	1,807	2,014
1891, . .	Oats, bushels, . . .	15	-	5.2	12.5	12.8	8.8	15.6	18.1
	Straw, pounds, . . .	950	-	267	940	1,030	380	1,720	3,260
1892, . .	Hay, pounds, . . .	640	—220	107	1,140	960	1,390	1,600	2,070
	Rowen, pounds, . .	80	160	773	—40	280	1,100	500	1,600
1893, . .	Hay, pounds, . . .	1,023	154	349	760	1,057	314	1,293	1,705
	Rowen, pounds, . .	161	29	473	55	328	991	719	1,318
1894, . .	Corn, bushels, . . .	1	—3.3	20.3	—8.2	15.4	32.8	34.3	41.8
	Stover, pounds, . .	580	20	1,320	—620	1,640	2,200	2,160	1,980
Total values, .	Fertilizer, applied, . .	$24 00	$24 00	$20 40	$48 00	$44 40	$44 40	$68 40	$150 00
	Increase in crop, . .	29 59	2 70	75 81	25 01	71 91	103 99	124 93	153 79

NOTE. — Abbreviations: "N." — Nitrogen, supplied in 160 pounds nitrate of soda each year.
"P. A." — Phosphoric acid, supplied in 320 pounds dissolved bone-black each year.
"Pot." — Potash, supplied in 160 pounds muriate of potash each year.

* Five cords per acre each year.

I will call your attention to these figures for a moment. Let me say in advance they do not show the yield; they show simply the increase caused by the fertilizer used. You will notice the letters, — "N.," which stands for nitrogen; "P. A.," for phosphoric acid; "Pot.," for potash. In supplying nitrogen we have used nitrate of soda at the rate of 160 pounds to the acre. In supplying phosphoric acid we have used dissolved bone-black at the rate of 320 pounds per acre. In supplying potash we have used muriate of potash at the rate of 160 pounds per acre. There are many valuable points shown by these figures. They refer to an acre of land which has been for six years under the same management. Upon one section of the field we have been applying nitrogen, as indicated by the letter "N.," for six years, beginning with 1889. The crop in that year was corn; in 1890, corn; in 1891, oats; in 1892 and 1893, grass and clover; and in 1894, corn.

The figures in the column headed "N." show the amount of increase in the crop which resulted from applying nitrate of soda alone. You will see the figures for the first two years for corn are small; in the second year there is an actual decrease. That does not necessarily mean that the nitrate of soda was injurious. The crop was smaller where it was used; but I believe that result was due to other causes. The nitrate of soda simply has no practical effect in increasing the corn crop. But in the next year for oats there is an increase of 15 bushels of grain and 950 pounds of straw. In the next year with grass and clover there is an increase of 640 pounds to the acre in the first crop, and in 1893 an increase of 1,023 pounds. You will notice that there was very little effect upon the rowen crop from nitrate of soda in either year. Its effect upon the first crop is great, but its virtue is soon spent. It does not benefit the rowen crop.

Phosphoric acid is at a disadvantage all the way through, — a very small increase in the corn crop the first two years, no effect to amount to anything on the oats, and very little effect on the hay, or the last year on corn. There was a large increase in corn each year with potash. This last year, where this land now for six years has had yearly only muriate of potash, we got an increase of 20 bushels of corn to the acre.

The nitrogen and phosphoric acid together did not do much good until oats were the crop. There is an increase of the first crop of grass in this column, due no doubt to the nitrogen, but no increase of rowen. There is no increase in corn for the year 1894 in this column, for there is no potash.

In the next column nitrogen and potash come in, and you see the corn crop is largely increased each year. On the oats there is an increase due to the nitrogen. On grass we have an increase in the first crop, due to nitrogen, but comparatively little increase in the second crop.

The effects shown in the next column, where phosphoric acid and potash were used, are similar to those produced where potash only was used.

Then we have nitrogen, phosphoric acid and potash, and here we see potash again produces its effect on the corn. The nitrogen in this combination produces also a large effect on the oats and the grass.

The effect of potash on grass and clover all the way through should be noted. With potash alone there is not much increase in the first crop, but a large increase in the second. This is because potash favors the growth of clover, which makes the rowen. Where nitrogen and potash are used the two crops are nearer together, but there is a moderately large increase in the rowen. Here, where the nitrogen and potash were used, it was the nitrogen that gave us the increase in the first crop, and there is also a moderate increase in rowen, due to potash. Where we have used phosphoric acid and potash there is a larger increase in rowen but little increase in the first crop, because there is no nitrogen.

My chief ground of criticism of special fertilizers as we find them lies in the fact that their composition is not what it should be. Almost without exception they contain too large a percentage of phosphoric acid, and too little of either nitrogen or potash or of both of these. To obtain as much potash as he requires, he who depends exclusively upon special fertilizers must purchase much more phosphoric acid than is necessary. Permit me to call your attention to figures which illustrate this point: —

Averages of Special Fertilizers.

	Nitrogen (per Cent).	Phosphoric Acid (per Cent).	Potash (per Cent).
Twenty-one potato fertilizers,	2.7	10.4	5.7
Four corn fertilizers,	2.8	12.4	4.0
Four grass fertilizers,	3.9	8.9	4.9

These figures are computed from figures given in the last annual report of the State Experiment Station, and every analysis for these crops except one for potatoes and one for corn was included; these varied so widely from the others that it was thought best to omit them.

I left them out because they contained so much potash they were not fairly representative. In taking the amount of phosphoric acid I have taken the total. Some would say I ought to have included only the available phosphoric acid; but the available in most special fertilizers is a very large proportion of the whole, and I thought it best to take the whole.

From the same report I take the following figures: —

Relative Proportion of Phosphoric Acid, Potash and Nitrogen.

	Phosphoric Acid.	Potash.	Nitrogen.
Mangolds,	1.0	6.0	2.3
Red beets,	1.0	4.1	3.3
Turnips,	1.0	3.9	1.8
Cabbage,	1.0	4.1	1.7
Corn (whole plant),	1.0	2.2	2.8
Onions,	1.0	2.6	2.1
Potatoes,	1.0	3.6	2.1
Potato tops,	1.0	2.7	3.1
Computed by myself: —			
Clover hay,	1.0	5.1	4.9
Timothy hay,	1.0	3.3	2.8

I leave it for you to judge whether these figures indicate that special fertilizers are correctly proportioned. In forming a conclusion it is desirable to take into account also the composition of soils, and here I ask your attention to the figures showing partial composition previously given. It will be seen that there is considerable variation. In a number of instances there is much less potash than phosphoric acid, but in some cases the opposite is true. It should be remembered, however, that these figures do not necessarily indicate the requirements of the soil; and it so happens that experiments with corn, potatoes, oats and grass upon the Amherst soil and with corn upon the same soil as the Agawam "plain" at Westfield have demonstrated that potash is the more essential of these two constituents for these two soils.

EXPERIMENTAL EVIDENCE.

And this leads me to say that we are not obliged to depend upon theoretical reasoning to prove the greater need of potash on most of our soils and for most crops. Experiments in various parts of New England by many different men have shown this to be the case in the majority of instances. Dr. Goessmann's work indicates it, and in his published writings he advocates it. From his last report I quote the following in relation to garden crops: "A mixture containing the proportion of twenty-five per cent potassium oxide, twelve per cent phosphoric acid and twelve per cent nitrogen deserves a careful trial." I may be pardoned for calling particular attention to some of the more important results of the experiments carried out under my direction during the last six years in various parts of this State. They indicate in a striking manner the surpassing importance of potash as a fertilizer for corn, potatoes, beans, oats and clover. The greatest number of experiments relate to corn, and the average results of twenty-six experiments are as follows:

Increase per Acre produced by Different Elements.

AVERAGES OF TWENTY-SIX EXPERIMENTS.	Nitrogen.	Phosphoric Acid.	Potash.
Hard corn, . . .	5.24 bushels.	2.98 bushels.	9.5 bushels.
Stover, ...	379 pounds.	196 pounds.	1,028 pounds.

Here is twice as much increase caused by potash as by nitrogen, and about four times as much as that caused by phosphoric acid. These experiments have been scattered all the way from the east to the extreme west of the State. I should not be justified in concluding, from the results of a single acre in Amherst, that corn fertilizers should generally contain so much potash, because potash has produced a far greater effect in the increase of the corn crop than either nitrogen or phosphoric acid; but in this case there have been so many experiments with similar results that I feel pretty sure that I am right.

With rare exceptions the results have been similar to those indicated by these figures, and in a majority of instances still more favorable to the potash. The results for potatoes have been of the same character, but less marked. In the case of clover they have been decidedly in favor of potash. I may remark here, though I shall refer to this again, that for grass nitrogen appears to be the most important. I must not, however, dwell longer upon this part of my subject. I have said enough to indicate that I do not believe the best way to keep up the fertility of our farms is to buy and use special fertilizers. Good crops have undoubtedly been raised upon them, but I believe usually at an unnecessarily large expense for fertilizer, because of the excess of phosphoric acid for which the buyer must pay.

Reasons why Potash is Deficient.

That potash, more frequently than phosphoric acid, is relatively deficient in soils, is the natural result of known causes. First, most farmers in beginning to use fertilizers employed superphosphates, which contained no potash. Other materials commonly used were fish, bones and Peruvian guano, the first two being entirely, the latter almost totally, deficient in potash. It is true that wood ashes were somewhat used, but the supply was small, and the soapmakers often extracted most of the potash. I have shown that the special fertilizers of to-day are most of them rich in phosphoric acid and poor in potash, and many of you are using phosphates entirely. Second, all of our important crops take much more potash than phosphoric acid from the soil. Third, it is the potash to a far greater extent than the phosphoric acid which has been subject to loss in our farmyard and stable manures, because voided in the urine. Fourth, the practice of late so common, of buying concentrated feeds like bran, cotton-seed, linseed, oats, etc., for our cows and horses, enriches their excrements greatly in phosphoric acid and nitrogen, but not in potash. In view of these facts, can it be wondered that our crops generally show a greater benefit from potash than from phosphoric acid application?

It should not, of course, be understood that the latter is unnecessary. It is usually required, but not in the proportion in which it exists in special fertilizers.

ADVICE TO THOSE USING SPECIAL FERTILIZERS.

Many of you will doubtless continue to use special fertilizers. I have nothing to say against it. You do not believe you can study out anything better, or you fear the labor involved in the mixing of the materials. Upon such I would urge an experiment. On a part of your field, in addition to your special, use some material furnishing additional potash. For all the common crops except potatoes and tobacco this may be the muriate in amounts of from one hundred and twenty-five to two hundred pounds per acre; for potatoes, use high-grade sulphate at about the same rate.

Here I will tell you an incident. The superintendent of the State Farm at Monson came to me last spring in Amherst, and said he would like to consult me as to raising potatoes. He said he had bought a special potato fertilizer. I said, "If you have bought that, of course you want to use it. My advice to you is to use in connection with it about one hundred and fifty to one hundred and seventy-five pounds of high-grade sulphate of potash. Put it on alone, scattering it widely along the drill, — or mix it beforehand with your special fertilizer. If you are going to use one hundred and fifty pounds of that, mix in some of this high-grade sulphate with it, and put it on together." He said to me afterwards, "I left out the potash on a part of the field, just for a test, and, while I have not been very exact in measuring, I am fully convinced that where I used potash the crop was forty per cent better than where I did not use it;" and he said that he had been amply repaid for the expense and trouble of coming to Amherst.

Raw Materials and Chemicals.

Either of the terms "raw material" or "chemical," as applied to the numerous substances most of which furnish but one or two of the important elements of plant food, is in a certain sense inappropriate. Many of them are directly incorporated in mixed fertilizers. They are no more "raw" before mixing than after. Dried blood and dry ground fish are examples. The term "chemical" is appropriately applied, perhaps, to substances like muriate of potash, sulphate of potash and nitrate of soda, which have been subjected to a chemical process of manufacture before being put upon the market; but these are chemicals to precisely the same extent after mixture in the complete special fertilizers. They do not undergo any further chemical change. They are simply mechanically mixed with other materials. I prefer the term "unmixed fertilizers." All may properly be included under this single head, for all have a fertilizer value. They differ, indeed, very widely in their degree of availability, as well as in other qualities. Some are almost entirely unavailable, such, for example, as leather and apatite. These might properly be called "raw," because it is best to subject them to special treatment before applying them to the land. Others, like nitrate of soda and superphosphates, are immediately available. Between the two extremes we have every possible degree of availability. I shall consider separately materials valuable chiefly for nitrogen, for phosphoric acid and for potash.

Nitrogen Fertilizers.

Some of the more important materials which are used chiefly as a source of nitrogen mentioned in the probable order of their availability are nitrate of soda, sulphate of ammonia, dried blood and flesh meal. Besides these there are a number of animal substances rich in nitrogen but also containing considerable phosphoric acid. The more important are dry ground fish, tankage and bone meal. Cotton-seed meal, though less generally used, except by tobacco growers, should also be mentioned. Any of the above materials may sometimes be wisely used by the farmer as sources of nitrogen; and in determining which to purchase, the price of a pound of nitrogen should be one of the leading factors considered. The value to the farmer of a pound of nitrogen in these various materials may not be the same in all. If wisely used, the more available are generally the more valuable; but since the more available nitrogenous fertilizers are also more liable to waste by leaching, this is not the invariable rule. Many would prefer sulphate of ammonia and dried blood to nitrate of soda, because they are less subject to waste. It does not answer to make a heavy application of nitrate of soda in early spring to a slow-growing crop. For this reason I generally advise the use of a mixture of materials. Nitrate of soda may be used alone by making several small applications, but it is generally less expensive to make one application of mixed materials. As a means of feeding a crop with nitrogen I would use a mixture of nitrate of soda, dried blood, fish or tankage and bone meal. At present prices, however, it should be remarked that nitrate of soda is one of the cheapest sources of nitrogen in available form.

Other materials furnishing nitrogen, such as horn and hoof waste, wool and hair waste and leather, should be left to the manufacturer. Their action is so slow that it is inadvisable for the farmer to purchase them.

PHOSPHORIC ACID FERTILIZERS.

The more important of these, also mentioned in the probable order of their availability, are superphosphates (including dissolved bone-black), tankage, dry ground fish, phosphatic slag, bone meal, Florida phosphate, South Carolina phosphate, phosphatic guanos and apatite. Cotton-seed meal may also be mentioned as of considerable importance in some localities. Tankage, fish, bone meal and cotton-seed meal, it will be remembered, have been mentioned as also furnishing nitrogen. The others in our list furnish only phosphoric acid. In selecting from this list, the availability and the cost of a pound of phosphoric acid should be the points considered. In general, the more available the higher the cost. A pound of soluble phosphoric acid in superphosphates costs about six and one-half cents. A pound of acid almost entirely in insoluble form, as in South Carolina rock, can be bought for about three cents. If required for immediate use by the plant, the farmer must pay the higher price; but if he can buy and apply in advance of present need, he may effect a saving by buying the cheaper form. Nature will in the course of a few years render it available.

Dr. Goessmann's special phosphoric acid experiments are of interest in this connection. Without going into details, I may say that his plan is to apply equal money's worth of phosphoric acid in different materials to plats of land liberally supplied with nitrogen and potash. The materials selected have been dissolved bone-black, South Carolina phosphate, Florida rock phosphate, Mona guano and phosphatic slag. According to the system followed, two or three pounds of phosphoric acid in the cheaper natural phosphates have been applied for every one pound in the bone-black. This experiment began in 1890, the crop being potatoes. The dissolved bone-black gave the largest crop, but was followed closely by the South Carolina phosphate and the phosphatic slag. In 1891 the crop was winter wheat. The South Carolina phosphate, Mona guano and the slag each gave a larger yield of grain than the bone-black, but the latter gave considerably more straw than either. In 1892 the crop was serradella. The plats in the order of their yield, beginning with the largest, were: phosphatic slag, Mona guano, South Carolina phosphate, dissolved bone-black and Florida phosphate. The last-named, however, received no phosphate the previous year. That plat the first year received apatite, but the second year it was not possible to get any apatite, and therefore no phosphate was applied. In 1893, the crop being corn, the order of yield of grain was: Mona guano, South Carolina phosphate, dissolved bone-black, phosphatic slag and Florida phosphate. Both the slag and the Florida phosphate stood relatively much higher in yield of stover. During the past year the field has been in barley without the further application of phosphates, and the order of yield has been: phosphatic slag, Mona guano, South Carolina phosphate, dissolved bone-black and Florida phosphate. This result is similar to that of preceding years.

The essential point to be noted in connection with these experiments is, that while at first the dissolved bone-black gave the largest yield, in the second year, even, the cheaper natural phosphates exceeded it, and have exceeded it every year since. No one will doubt that they will continue to exceed it for several years if the land be left without the further application of phosphates, for they have been used (at the same cost) in two or three times greater amounts.

Potash Fertilizers.

The more important of these are sulphate of potash, muriate of potash, kainit, potassium and magnesium sulphate and wood ashes, the latter supplying also phosphoric acid. More recently a double carbonate of potash and magnesia is being offered from Germany. It is claimed to be very superior for tobacco and fruit crops. This is the same compound of potash which comprises the most valuable portion of wood ashes. In all of the materials named the potash is quite promptly available; a portion of that in the ashes is the least so. At present prices the muriate of potash is the cheapest source of this constituent, and it may be safely used for most farm crops. My experience indicates that for the potato the sulphate is superior, producing the larger yield, and of superior quality. My method of judging of the quality was this. I had an assistant select samples of potatoes raised on muriate and on sulphate. He sent a peck of each kind to the families of President Goodell and Professor Maynard, to my family, and took a peck of each kind home to his mother. In each case none of us knew what we were testing. The experiment was continued three years, and as the result, in 1891 each family said unhesitatingly that the potatoes raised on sulphate were far better than the others, being more mealy, whiter and of better flavor. The next year none of them could tell the difference. This year they were unhesitatingly of the opinion that the sulphate potatoes were much the best. The seasons of 1893 and 1894 were very dry. In dry seasons muriate might produce potatoes of a very fair quality, but when there is much moisture sulphate will produce a much better quality.

There is some evidence that the muriate, if applied during the autumn or winter, will answer equally well. I have planned to test this point the coming season. I am aware that many prefer ashes as a source of potash, and it is doubtless true that their physical and chemical effect on many soils gives them an advantage. When, however, one is looking for a material which will furnish available potash for least money, he cannot afford to take ashes. The potash in them generally costs about eight or nine cents per pound. In the muriate it can be bought for about four and one-eighth cents per pound.

How to keep up Fertility with Fertilizers.

In summing up the whole question of the best method of using fertilizers, I have to say that I am strongly impressed with the wisdom of the plan proposed by Wagner, which you will find described at length in a translation by Dr. Chas. Wellington, published in the Agricultural College report for 1890. Stated as briefly as possible, the plan is as follows: —

Since phosphoric acid and potash are retentively held by soils, it is recommended to apply these liberally during a series of years, selecting for the purpose the cheapest forms, with a view to accumulating a reserve or working capital of each. It should be remembered that a very large excess of either may prove injurious. There is, however, little danger that the average man who depends upon the farm for a livelihood will apply enough to be harmful. Continue this liberal yearly application as finances make possible, until a simple experiment, that is, leaving it out on a part of the field, shows that a further application will produce no increase in the crop. Thereafter from year to year aim to apply a little larger amount of each than the crop removes from the field. This very slight excess may serve to cover any possible loss of any constituent.

I would advise the opening of an account with each field. On the one side charge it with the food applied; on the other, credit it with the plant food recovered in the crop.

You will look for a close agreement between the two sides only in case of the phosphoric acid and potash. The nitrogen, you remember, is subject to waste. You think such an account will involve much labor, but you are mistaken. The Experiment Station publishes already reports which make it simple. The matter can, however, be still further simplified, and doubtless will be. Let the station issue tables which show how many pounds of nitrogen, phosphoric acid and potash there are in one hundred pounds of different fertilizers; how many pounds in a cord of manure; how many pounds in one hundred bushels of grain, vegetables, etc.; how many in one ton of hay; and, knowing what you apply and the crop harvested, there is not one of you but can fill out the account at a glance. Set your boys and girls to work upon it. It will provoke thought, both in them and in you. It will be as serviceable in its field as a cash account is in regulating expenses.

I cannot tell you how to make the two sides balance. If we knew, farming would be royally profitable. The plant food in one hundred bushels of potatoes can be purchased for about five dollars; that in all other important crops for a figure much below their usual value. There is ample margin to cover interest, taxes and labor. It is because we waste so much that our crops are unprofitable. Let us adopt means to know just how much we are throwing away. When we understand in what the leak consists, and how great it is, we shall set to work the more earnestly to prevent it.

I would keep the account with nitrogen as well. Here, however, is a leak — toward the sea — that perhaps we shall never be able to entirely prevent. Wagner says that we must expect — even on land where there is an abundance of phosphoric acid and potash — to apply three pounds of nitrogen for every two recovered in the increase in the crop. I hope we shall some day be able to do better. Let us know the exact size of the leak in our own farming operations. I fear most of us pay more than three for two.

In feeding crops with nitrogen we must always keep in mind that the soil does not long hold this element. This has already been stated, but the matter is of much importance. In providing for the crop of any season, combine quick and slower acting materials as a rule; or, if you decide upon nitrate of soda, apply half at planting, one-fourth when the crop is one-quarter grown, the balance when it is half grown. As for the amount to use, until we learn how to do better, apply once and a half what the increase expected in the crop will remove, except for legumes; for these use but a very small amount to give them a start; force them to draw from the air.

General Rules.

For corn, potatoes, clover, peas and beans make potash a prominent constituent of the fertilizers used. For grass, and in general for all crops which start into growth very early in the spring, use nitrate of soda freely. This is necessary, for the fall and winter rains wash out of the soil most of its available nitrogen compounds. During warm summer weather such compounds are formed by natural agencies from the organic matter in the soil, and are ready in season to feed a late-growing crop like corn. For such a crop, therefore, it is unnecessary under ordinary circumstances to apply a large amount of nitrogen.

Phosphoric acid hastens the ripening of most crops, and a liberal use of it may be an advantage where earliness is particularly desirable. It is also, according to Wagner, particularly essential for all fodder crops.

Summary.

The leading points that I have endeavored to bring out are the following: —

1. The productiveness of soils depends in no small degree upon their physical character.

2. To secure the conditions essential to the best effects of manures and fertilizers, and to utilize in so far as practiable the natural resources of the soil, which are enormous, good drainage, fall ploughing and thorough tillage are essential.

3. Soils can hold phosphoric acid and potash; they do not hold soluble nitrogen. We may wisely endeavor to accumulate a reserve of the two former, but not of the latter except in the form of organic matter.

4. The culture of suitable crops which can grow late in

the fall enables us to both conserve and gain nitrogen. The latter purpose is well served only by leguminous crops, of which the clovers are the most important. We should aim never to allow fields to lie bare during the season when the ground is open. It often pays better to feed crops grown for this purpose than it does to turn them in. The stubble and roots have a great manurial value.

5. So manage as to prevent loss of urine and ammonia of manures. Apply to the fields when fresh, aiming to reduce the labor of handling to a minimum.

6. Special fertilizers are not correctly proportioned; they contain relatively too high a proportion of phosphoric acid. If they are to be employed, use potash with them.

7. It is generally best to use manure and fertilizer together rather than each by itself.

8. Unmixed fertilizers in great variety can be obtained, and by their use in connection with home-made manures the farmer can keep up the fertility of his fields at least expense.

9. In the use of phosphoric acid and potash follow the plan of accumulating a large working capital.

10. For phosphoric acid depend chiefly upon the cheaper natural phosphates to accomplish this.

11. For potash the cheapest present source is the muriate.

12. In supplying nitrogen use mixed materials of different degrees of availability; or, if choosing to depend on nitrate of soda, apply at two or more different times. Do not apply nitrogen in large excess of the requirements of the crop under cultivation.

13. Open an account with your fields, charging each with the plant food applied, crediting with the amounts removed in the crops. Try to make the two sides of the account balance. We should be able to do this pretty nearly for the phosphoric acid and potash; we cannot expect so close an agreement for the nitrogen.

In conclusion, I believe in general in broadcast application both of manure and fertilizer, and would keep both near the surface. In some cases a part of the quick-acting fertilizer may with advantage be put in the hill or drill. For potatoes, drill application of all the fertilizer has given a larger yield than broadcast in three experiments. This was upon land of moderate fertility.

For crops in general, materials supplying from forty to sixty pounds of nitrogen, from forty to sixty pounds of phosphoric acid and from sixty to a hundred pounds of potash will generally give satisfactory results, provided a system of rotation including some legume is followed to furnish a part of the nitrogen. If this is impracticable, considerably more of this element must be furnished.

You have perhaps expected that I should give you formulæ for different crops. I do not consider it best to do this. I do not know your soils, I am unfamiliar with your conditions. If you shall desire to know what I have used, and the results, I can tell you; but I cannot promise equal success to you.

Just one more point, and I am done. If plant food is to be purchased, my experience leads me to believe that fertilizer will furnish it at less cost than manure. For six years two plats of land have been continuously under the same treatment on our grounds at Amherst. One has received yearly nitrate of soda at the rate of one hundred and sixty pounds; dissolved bone-black, three hundred and twenty pounds; and muriate of potash, one hundred and sixty pounds per acre. The other has received yearly five cords of good manure. The crops in the order of succession were: corn, corn, oats, grass, grass and corn. The *increase* in crop due to the use of fertilizer has been worth $124.93; the fertilizer has cost $68.40 for the six years. The increase where the manure has been used has been worth $153.79; the manure at five dollars per cord has cost $150. The chief superiority for the manure has been in the grass crops, doubtless because of the more liberal supply of nitrogen. In six years where the fertilizer has been used we have applied one hundred and twenty pounds of nitrogen; where the manure has been used, we have applied not less than six hundred pounds of nitrogen. The fertilizer could have been made to make a much better yield of grass by the use of more nitrogen.

On the college farm I have for five years been comparing various mixtures of fertilizers with manure for grass. The increase in crop pays for a judicious mixture of fertilizers; it has not paid for manure at $5 per cord.

QUESTION. Professor, referring to your table of increases, doesn't the wet or dry season affect that rowen to some extent?

Professor BROOKS. Of course it will affect the total amount of rowen; but it is not a question of the effect of the season, but the effect of these different materials. The figures on one horizontal line are all for one season. Potash favors the growth of clover, and that is why when it is applied there is usually a large increase in rowen. That is a point worthy of notice, because clover is such a valuable crop. Many of you have seen this acre of land when it was in mixed grass and clover; and I can assure those of you who have not, that, if I had given you the clue before you started, and you had crossed the field when in grass, you would have told me when you had finished your trip which plots had received potash, because where potash had been used there the clover was growing, and where no potash was used there was no clover.

QUESTION. Do you find deterioration in the quality of English hay in connection with nitrate of soda?

Professor BROOKS. The crop has not been analyzed, but I have no reason to suppose there would be. The albuminoids are among the most important of the constituents of hay, and science teaches that where nitrogenous fertilizers are used the percentage of protein or albuminoids is increased. Clover is especially rich in albuminoids or protein, so that that would complicate the matter, and my first remark would apply to the effect upon the grass crop only.

QUESTION. I understand that the effect of the nitrate of soda is in every case shown only in the first crop, and that it does not affect the amount of rowen?

Professor BROOKS. Yes, there is very little rowen. Its effect is all spent on the first crop.

QUESTION. On the other hand, the rowen is increased by potash?

Professor BROOKS. Rowen is increased every time by potash. You study the figures a little carefully, and you will see that is the case all through. On this grass land there are four plots which during the six years have not received anything whatever. They are in different parts of the field, and I wish you to remember that the figures represent only the increase in the yield where fertilizers were used compared with the plots which received nothing. Now, one year, 1892, my assistant by accident put some nitrate of soda on one of these plots which should have received nothing. For the two previous years I had had a chance to see what that plot was doing. I had been growing corn there, and it had not been doing any better than the other three nothing plots in the acre. By accident, as I say, he got at the rate of one hundred and sixty pounds of nitrate of soda to the acre on that plot. The result was we got almost as large a crop of hay there as we did where we had been using manure every year, but we did not get any rowen, and we did not get any larger crop of hay the next year. The yield went right back again where it belonged. The effect of nitrate of soda on grass early in the spring is almost magical. This is an illustration of a principle which I have stated in my paper; but perhaps I had better clinch the point right here. The effect of nitrate of soda is almost magical upon every crop which makes its chief growth very early in the season. That is an explanation in part why nitrate of soda has been so beneficial wherever it has been used on grass and oats. Nitrate of soda for corn is not of much use, but for oats and hay there is a large increase. While oats and grass make their chief growth in the cool spring weather, corn needs hot weather.

QUESTION. Do you recommend applying it early to grass?

Professor BROOKS. Yes, as soon as the grass will begin to grow; and I will explain why this should be so. The rains of the fall and winter leach the soluble nitrogen out of the soil, and the crops which have got to make their growth early in the spring must be fed with soluble nitrates. Those that do not make their best growth until after considerable warm weather, like corn, can get their nitrogen from the soil, because natural agencies working on the organic material of the soil change its nitrogen into available form. The following important difference in the use of fertilizers you should all fix in mind. Feed those crops that grow early in the spring with nitrates, but to those that make their growth later the application of nitrogen is less necessary.

QUESTION. Do you buy the chemicals at the college and mix them yourself, or do you buy those ready mixed, and apply them?

Professor BROOKS. I generally buy the chemicals.

QUESTION. Does the white mustard referred to spread on the land?

Professor BROOKS. No, sir. It is very different from the black mustard. Black mustard becomes a weed. I have never seen a single volunteer plant of white mustard on the college farm, although I have been using it for six years. If sown the first of August, it does not ripen the seed. It comes into bloom and makes a splendid pasturage for bees. There is a buzz and hum all over the field.

QUESTION. Is that seed readily obtained?

Professor BROOKS. It can be readily obtained, but it can be much more cheaply grown. I bought some at first, but I found if I sowed it in the early spring it would cost but very little to raise it.

QUESTION. Will cattle eat it?

Professor BROOKS. Cattle will eat it readily, sheep and young cattle particularly. I put the sheep on this white mustard along about the middle of November.

QUESTION. Would they eat it better if carried into the barn?

Professor BROOKS. Well, I suppose there would be less waste, because they trample it somewhat in the field. Still, it produces large crops. I do not wholly lose that part of it which is trodden down. I think if you keep sheep or young cattle, if you are anxious to make the most possible out of its food value, you can do better than by turning them into a large field. Have a portable fence, and make them eat one section down clean, and then remove them onto another section. That is also important because it enables you to manure all parts of the field the same. If you turn animals into a large field, most of their droppings are left in some favorite place; but if you move them from section to section, using a portable fence, you manure the field all over.

QUESTION. Will it stand frost?

Professor BROOKS. No, it won't stand winter. It has continued to grow until about the middle of November That is the average for the last six years.

QUESTION. You say the seed can be readily obtained?

Professor BROOKS. Yes; most large seedsmen keep it.

QUESTION. What is the amount of seed sown per acre?

Professor BROOKS. We sow from twelve to sixteen quarts to the acre, broadcast at the time of the last cultivation of the corn.

Dr. TWITCHELL. Is not the percentage of waste greater when the manure is spread upon the fields through the winter than if it is allowed to remain in the pile?

Professor BROOKS. I do not think it is, for these reasons. You will understand me that I am talking about fresh manure, not fermented manure, and the percentage of soluble materials in fresh manure is comparatively small. Ammonia does not exist in fresh manure. It forms very quickly if it lies in a loose pile, but spread out upon the soil it forms very slowly, and moist manure can hold considerable of it. I do not think it will escape into the air. There is no evidence that it does, because every rain that comes washes it out into the soil. Since you have asked the question, it is perhaps desirable that I should relate a little bit of experience in this connection. I should say that most of our grass land slopes quite a little, and one of my students asked me (they are very fond of catching a professor when they can) if there was not a great deal lost by this practice; and one day when the manure was applied there was some ice and snow in the field, and a sudden change of weather with rain produced conditions in which there was considerable water running off the field. Then the student came and said, "There is a great waste here." I said to him, "I am as anxious to know the truth as you are. Go and get a sample, and have it analyzed." He did so. Without going into details, in order to make the result impressive to the class, I calculated the value of a barrel of such water, and I found that, allowing the full manurial value of the constituents contained, a barrel full of material which was washing over the surface was worth one-fifth of one cent.

QUESTION. Let me ask you how many barrels ran off in a day that way.

Professor BROOKS. It is difficult to estimate, but that also I calculated. Let us suppose it was an exceedingly heavy rain, two inches, and if I am right in my recollection as to the value of this material in a rainfall of two inches, was under two dollars per acre. Now, understand me. I do not advocate the spreading of manure on slopes covered with ice. Put it in the winter as far as practicable on level land, upon grass where there is no slope, and where there will be no wash, and I have no evidence of any instance where there is any loss. I have always noticed, where the manure was put on in the late fall or early winter, the crop was much better than where it is put on in the spring.

QUESTION. How much loss is there in manure such as usually comes from Boston?

Professor BROOKS. There is undoubtedly considerable loss. This Boston manure has in many instances lost a good part of the urine, which is often let right into the sewer and carried off, the only object being to get rid of it.

QUESTION. I would like to ask the professor whether he calls manure made from the stock in summer green manure, or not?

Professor BROOKS. No, sir; I should simply call it fresh cow manure or barn-yard manure.

QUESTION. Would you apply that in the winter, and not plough it in?

Professor BROOKS. Yes, I would use it for any ordinary purpose of the farm. We generally put it on as soon after it is made as we can. I advocate putting it on while it is fresh.

QUESTION. We are making green manure during the months of July, August and September. What would you do with it? Would you put it on top of the ground?

Professor BROOKS. If the condition of the fields on the farm permit, I should put it on about as fast as it is made. If I did not have any fields in condition to put the manure on, I should be forced to let it accumulate on a water-tight surface, with a roof overhead. I should want to scatter on it occasionally an absorbent, such as plaster or kainit, so as to help keep the ammonia in it, and I would like also to keep it trodden down solid, so it would not heat too fast.

QUESTION. Professor, you know most of these gentlemen here in the old style of farming have been accustomed to let the manure remain during the winter and get it out in the spring, and get out only a little at a time before they plough it in, thinking that there would be great loss. Would you advise them to harrow or plough it under immediately, or get it out and spread it, and let it remain until it was convenient to plough it in?

Professor BROOKS. That would depend in part upon the manure. There are manures from which there is quite a rapid escape of ammonia. If they were spread out and allowed to remain on the surface, there might be so much loss it would amount to a serious matter. But not everything that smells bad is manure; not always when your dressing has a rank odor does it mean that ammonia is escaping.

Before this discussion closes perhaps I ought to add just a word. I have taken the ground that "special" fertilizers do not as a rule contain a sufficiently large percentage of potash, while they do contain much more phosphoric acid than would appear to be required. In justice to fertilizer manufacturers it seems only right to say that a fertilizer must not only be made with reference to certain theoretical proportions of the different chemical elements required by plants, but must also be so compounded as to remain in suitable mechanical condition for application. If made with the proportion of potash and phosphoric acid sometimes recommended, a fertilizer would be certain to cake. The excess of phosphate added serves to keep fertilizers dry and to prevent caking, and is in this way useful. It is further undoubtedly true that some manufacturers now offer "special" fertilizers much richer in potash than a few years ago; and it is perhaps true, as they claim, that they have complied with the general demand for fertilizers richer in potash to as great an extent as practical and economical conditions allow. Under the existing circumstances, then, it may be unreasonable to expect them to offer at once fertilizers as rich in potash and as low in phosphoric acid as I have recommended.

Adjourned to 2 P.M.

AFTERNOON SESSION.

The meeting was called to order by Secretary **SESSIONS**, who called upon Professor **MAYNARD** to further explain the apparatus which he had on exhibition in the lower part of the building.

Prof. S. T. **MAYNARD**. Two of the evaporators which we have below, the Stahl made in Illinois, and the American made in Pennsylvania, we obtained for determining whether it would be profitable to evaporate our waste fruit. We ran the American last year through two or three weeks, enough to test it, and this year we have run the three kinds side by side. These evaporators which are in the room below are too small for profitable use except perhaps upon a farm where you have the help of children and other not very expensive labor. The results from the tests which we have made are not wholly satisfactory. We found that we could not evaporate as much fruit as we could prepare by means of the parer and slicers which we have, but they will illustrate the different forms of evaporators which are in use.

For spraying apparatus we have the force pump, the power pump, the factory pump, as it is called. It sprays automatically, the power coming from the horses, and a man riding upon the machine is able to spray potatoes with no effort except driving the horses. For spraying apple trees and larger trees it is necessary to employ two men, one man to drive, the other to manage the nozzle. The barrel pump is placed in a cart, one man, the driver, pumping, while the man who walks carries the nozzle, spraying trees, potatoes, etc. There are two forms of the Douglass pump, made at Middletown, Conn., which are adjustable to the side of a barrel. The barrel may be placed horizontally in the cart, and by means of a cushion can be kept easily in place. The other one, fastened to the head of a barrel standing on end, would, in driving over rough ground, require to be kept in position so that it would not fall over the side of the cart, but it is a very serviceable machine. The knapsack pump can be used only in case of small trees and clumps where the larger pump cannot be driven, and nothing higher than fifteen or twenty feet can be reached with it. We have experimented with a number of pumps, and we find these among the best. There are some features in these that we do not find in any other. Here is the adjustable gem nozzle, which is very serviceable where a stream is to be carried a long distance to very high trees. The stream breaks at the end, and does not give the best results. The Vermorel nozzle is the best, because the stream comes out in the form of a very fine mist. We shall try to be at the spraying apparatus and evaporators so as to answer any questions which may be asked in the intervals of the meetings.

Mr. George M. Whitaker, assistant executive officer of the State Dairy Bureau, stated that no samples of milk had been furnished with which to use the Babcock milk tester, but that he expected to have twelve or fifteen samples the following morning, and invited any of the audience who desired to have milk tested for percentages of fat to bring the samples to him, stating that it would be better to have the milk from different breeds brought in separately, not mixed.

Secretary SESSIONS. At the request of the vice-president of the Board, I will announce that Mr. E. W. WOOD, chairman of the executive committee, will preside this afternoon.

The CHAIRMAN. As you remember, the subject of the lecture this morning was a consideration of how to profitably and economically feed the soil. This afternoon we are to consider how to feed the products of the soil most economically and practically. The committee has secured the service of a gentleman from across the imaginary line which we hope ere long will be obliterated, and I have the pleasure of introducing to you Professor Robertson of Ottawa, Can.

SUMMER AND WINTER FEEDING OF DAIRY COWS.*

BY PROF. J. W. ROBERTSON, OTTAWA, CAN.

Mr. Chairman, ladies and gentlemen: I am very glad to be in your State of Massachusetts. That the boundary line referred to is an imaginary one to many of your minds, I am well aware. Your chairman in introducing me this afternoon made one little slip. It illustrates what I mean; he said "from Toronto." That is two hundred and sixty miles from where I live. When I went to reside at Ottawa, the capital of our Dominion, I received a letter addressed in this fashion, — to myself, "At Ottawa, near Toronto, United States of America." So my correspondent, at any rate, was quite in evidence that the line was imaginary.

I am very glad to be here this afternoon in response to the invitation of your honorable secretary. My friend, Ex-Governor Hoard of Wisconsin, urged me to attend this convention. He said, "If you want to meet some of the bright men in agriculture, go to Massachusetts;" and when I was asked to come and speak to bright men, I had only this consolation, that it is rather pleasanter, when a man does not know a great deal, to talk to bright men than dull men, because they have some sympathy with you. In my judgment, the solid, the permanent prosperity of this nation depends upon a clear understanding of how to farm well; and the prosperity of your nation affects the well-being of ours very seriously. We have so much in common, that every step in advance which you make for bettering and broadening the conditions favorable for prosperous life for the common people we make shortly afterwards, and every step that we take forward, we think you will take shortly, — although you have not done so yet as speedily and largely as might have been expected of you in some respects.

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* Stenographic report by Mr. C. E. Barnes.

This afternoon I am to speak on summer and winter feeding of dairy cows. Why do we feed cows? A great many men feed cows for the sake of having company in the stable. I know no other adequate reason in some instances, — on the other side of the imaginary line, that is. Those who feed cows with any measure of good judgment, feed them to obtain food of a fine quality which they cannot get otherwise out of what they feed the cows. The primary object of feeding cows is to obtain a fine, delicious food of concentrated quality. The object of our agriculture is to obtain food and service out of the numerous plants that grow on our farms. If I had another chart in addition to the series which I am going to exhibit (for my object will be to teach through your eyes as much as I can), I would show you that the man, the farmer, must be on top and all the forces of nature under him, — all the agents and agencies of farm work and farm products under him. But in many cases on this continent the farmer has been under everything and everybody, trying to carry that big load on his back, instead of putting those things under his feet with his own intelligent head on top for management.

We feed cows to obtain food of fine concentrated quality, which we cannot get otherwise, or get so economically, or so much to our taste. That is my first proposition. When a man feeds cows by the use of his head, he will get far more milk and more profit from his cows than if he feeds them in a less intelligent way.

We feed cows perhaps for another reason, — because we have made some progress in agriculture. Primitive agriculture in all lands was concerned with getting a primitive product, — the corn stalk, the wheat plant, the bean stalk and grass plant; but as men made progress they learned to put the living domestic animal between the primitive products and themselves, and made the cow elaborate for them something finer and richer for their taste or their stomach. We follow dairying and feed cows because we cannot eat corn stalks with much enjoyment, and we cannot eat wheat with much relish unless we have butter for our bread, or oats with entire satisfaction unless we have milk or cream for our porridge. We feed a portion of the coarse farm products to animals, and we put the cow there between them and us as a means towards an end.

Unless we feed cows on our farms, we are ever under the necessity of buying, buying, buying tons and tons of expensive nitrogenous commercial fertilizers, which very few farmers on our side of the line have enough business skill to make money by using. But when we feed cows on our farms, instead of selling off the farms what the plants take out of the land (and that was beautifully, scientifically and eloquently explained this morning), four-fifths of it goes back on the fields in the form of manure; and we sell less substance off the land and receive more money into our pockets; therefore we feed cows to protect the soil, and a man who robs his land is the poorest kind of a farmer.

We do more than that. We feed cows to provide remunerative occupation for ourselves. What was it caused that dire calamity across the continent a year and a half ago, when so many people were without work, when money was so wonderfully scarce? Everybody's financial standing was in jeopardy. It was because a great many people had not the opportunity of remunerative employment to which to apply their strength and skill. A farmer on this continent in this latitude cannot find remunerative employment on his fields in growing crops for more than five or six months in a year; and unless he finds for himself some profitable employment during the other six months of the year, he will have to earn as much in six months as will keep him and his family comfortable for twelve months. Nowadays but few men can do that honestly; therefore he must find employment for himself during those months when he cannot work on his fields; and he can feed cows so as to aid him in obtaining the results which he desires, — specifically to make profit out of the operation.

If a cow will turn what you do give her into a more valuable product, then you can feed her at a profit; if the cow will turn it into a less valuable one, you will feed her at a loss; and just as the cow has ability and capacity for turning what you give her into a more valuable product, so far she is a good servant. If she does not do that, she is a very expensive boarder on a farm; and from what I have heard of your dairying here, there are some cows near Newburyport that have not paid their board bill in full for a long time. An animal does not destroy what it consumes, it changes it; and unless it changes it into a more valuable form, it wastes.

Then a cow that wastes is an ill-bred cow; that is the meaning of ill-bred everywhere, — a wasting of energies and opportunities of all kinds. That is the best definition I have ever found of ill-breeding among cows, — as well as men. I have known cows that had a faculty for making men swear. If the cow becomes the medium of changing corn stalks into cussedness, she is a very badly trained cow. If you handle a heifer from the time she is three months old by an occasional rubbing of her udder, she will stand as quiet as an old cow the first time the milk pail is put under her, and will return about twenty per cent more milk. That only goes to show the necessity and importance of careful preparation for the milking season.

Success in keeping cows depends a great deal upon the kind of feed you give them. I will use a few extravagant illustrations to make what I say stick in your memories. If you feed a cow on strawberries, it will not pay. There are many kinds of food which a cow will eat and relish, which she will not turn into milk *at a profit;* and therefore it does not pay to give them to a cow.

Then a great deal depends on the man who manages. The man and cow are always in partnership. If a cow has her way, she will get the largest quantity of rich feed, and give the least of product in return for it. If a man of good judgment has his way, he will make the cow give the largest return in good milk for the least possible value in food. He will be the senior partner in the partnership, and his judgment should prevail.

I have said so much by way of giving you the very edges of the theory of feeding cows. Any theory that has not grown out of facts is not a valuable theory; but a theory that is built and based upon facts will enable a man who understands it to put his facts afterwards into such relationship that they will serve him better. In feeding cows certain constituents of feed called albuminoids, I want to know why the cow should get these things. Not because anybody who is an authority said so, not because a certain table or book recommended it, but because our bodies are in part composed of albuminoids, and we want the cows to give us in milk what we need as food. I have put on this chart those chemical compounds which are in the human body, of the average weight of one hundred and forty-eight pounds.

CHART NO. 1.

Chemical Compounds in Human Body of One Hundred and Forty-eight Pounds.

	Pounds.	Percentage.
Water,	90.0	60.9
Albuminoids,	26.6	17.8
Fats,	23.0	15.5
Carbohydrates,	.1	.1
Mineral matter,	8.3	5.7
	148.0	100.0

The body needs these things to form the muscles and nerves, blood and skin and other parts of the body. In performing the functions of life some portion of those albuminoids are worn out from the blood and skin, the muscles and nerves, and are carried off in the sewerage system from the body. We must swallow something to replace what is worn off, else we shall wear out; and I at least have no desire to do that for forty years if I can help it. Therefore I want to get from the cow a part of her albuminoids.

Then in my body and in your body are fats, — fats for heat and fats for lubrication. In feeding cows we find that albuminoids are somehow in some measure transferred into fats. Now, if you can give a boy food rich in albuminoids, you give the boy what is called elbow grease to enlarge the efficiency of his body. But if you feed a boy on pastry and similar things you get something that is not elbow grease. I do not know what you call it over here. On our side we call it dyspepsia plus laziness. The same principle applies to cows and calves. We have some cows that are absolutely lazy towards milking, from having been fed on the wrong food when they were young, — constitutional laziness from which they can never recover.

The body is mainly composed of these things, water, albuminoids, carbohydrates, fats. While my body is composed of certain substances, I, like other living organisms, need fuel to keep up the heat. There are almost no carbohydrates in the body itself; they are its fuel.

CHART NO. 2.

Composition of Nutrients, in Percentages.

	Nitrogen.	Carbon.	Oxygen.	Hydrogen.
Albuminoids, . . .	16.0	53.0	24.0	7.0
Fats, ...	None.	76.5	11.5	12.0
Carbohydrates, starch, .	None.	44.4	49.9	5.7
Carbohydrates, sugar, .	None.	42.0	51.0	7.0

The albuminoids, fats and carbohydrates come from four elements or sources. Albuminoids only of the three contain nitrogen. I would not have shown some of these charts, after that clear and comprehensive lecture this morning, except to make my own address as clear and serviceable as possible. Four-fifths of the atmosphere everywhere may be termed nitrogen. The albuminoids contain sixteen per cent of it, and if you can grow any sort of a plant that will glean it from the atmosphere, then you may obtain it in such a form that the cow first, and the man afterwards, can use it as food. Hence when you say that people cannot live on air, the remark requires some qualifications; because, when a man is wise enough to manage the agricultural agents and agencies of nature, he will live largely on air, or on what came from air. He has been doing it in the past, but he was not able to control the means intelligently.

I was pleased to hear the learned lecturer state last evening that in his judgment skimmed milk was far more valuable for human food than we had yet come to recognize. The albuminoids are all there, and it is a valuable food. Of sugar there are five pounds in every hundred pounds of skim-milk. Over large areas of your country and ours it is fed to swine. If we understood its value as human food, we would count it too costly a food to give to pigs, because that kind of sugar is worth rather more for sustaining life than any other sugar you can obtain.

I will say a word or two on two or three typical foods. I need not try to give you definitions. One hears a great deal said in reference to the feeding of cows according to what is called the correct nutritive ratio. "The nutritive ratio" is a phrase familiar to many minds, and its meaning is not at all clear to others.

For the sustenance of human life in a healthy person, I dare say you would find oatmeal to have a very excellent nutritive ratio, that is, the quantity of albuminoids would be in such a proportion to the quantity of fat and carbohydrates as would meet the needs of a man's body in the best way with the least waste. Food may be spoken of as substances taken into the body to repair waste by replacing worn-out or worn-off particles, to furnish heat or energy, and in the case of those animals that give an increase in weight or give a product, it supplies the materials out of which these are formed.

CHART NO. 3.

Composition of Some Common Foods, in Percentages.

	Water.	Albuminoids.	Carbohydrates.	Fat.	Ash.
Oatmeal, ...	10.0	15.0	69.0	5.0	1.0
Rice, ...	12.4	7.4	79.4	.4	.4
Pease, ...	15.0	22.9	57.8	1.8	2.5
Beans, ...	15.1	25.5	55.0	1.6	2.8
Pork (fat), ...	10.0	3.0	–	80.5	6.5
Potatoes, ...	75.5	2.0	21.3	.2	1.0
Beef (rather lean), . .	66.7	23.0	–	9.0	1.3
Milk, ...	87.0	3.5	5.1	3.7	.7
Wheat bread, . . .	32.7	8.9	55.5	1.9	1.0
Butter, ...	12.0	1.0	.5	83.5	3.0
Cheese, ...	35.0	25.0	2.3	34.0	3.7

If you compare rice with oatmeal you will find that the difference between these two means a great deal for the race. It shows the difference between the Scotchmen and the Chinese. Oatmeal or rice, — it means a great deal. If you use a well-balanced ration, then you will be a well-conditioned, effective individual. Down here I am told that you are fond of baked beans, but baked beans are not quite wholesome and economical when eaten alone. You see they are rather rich in albuminoids as compared with oatmeal. You will be right in measuring all those things — and probably most other things — by the Scotch standard; and if you will put with your baked beans a small quantity of pork (you see the pork has too much fat and far too little albuminoids), then you will get a capital combination as to its nutritive ratio. Then take other things. Oatmeal and milk make a capital mixture. In potatoes you have far too little of the nitrogenous in proportion to the carbohydrates. How can you adjust that to make it good food for nourishing the best class of human flesh? I am speaking of man in his material nature only, you see. If you take the milk and take the fat out, and then add the remainder to the potatoes, why, you make the diet as good as a Scotchman's diet of oatmeal and milk. Thus potatoes and buttermilk for the Irishman, judged by the results, are not a bad combination.

I have mentioned these three typical foods to say that it was not an intuition that led people to combine these things; but it required long experiments, probably extending over several centuries, before we learned how to make an economical diet of the correct nutritive ratio suitable for ourselves, and it is by long-continued and carefully conducted experiments that we have been led to the making of a ration of the correct nutritive ratio for our cattle. The cow was made to be a servant of man, and if a man persists in feeding a cow in disregard of the results from the long-continued experience of others, he will find that he is not following a very profitable or noble vocation. But if you will put these constituents in correct proportion in the cow's feed, getting them at the lowest possible rate of cost from your own fields, then the feeding of cows becomes one of the most profitable occupations that can be followed on farms, in spite of all competition from all sources and all lands.

Let me illustrate that still further, because I find that great failure comes to our farmers from not understanding the first principles of feeding. It is not enough to give a cow plenty to eat, unless that plenty be of the right constituents. What would you think of a rich man who wanted to be kind to a poor family, and who sent them abundance of food when they did not have any fuel in the house, and did not send them any fuel? If they had to use part of the food as fuel in a stove in order to get the benefit of it, that would be a very extravagant practice, would it not? That is what people do to-day who give too large a portion of albuminoids to their cattle. Or what would you think of a man who sent a family suffering for food a quantity of fuel, but nothing to eat? That is similar to what a man does who gives a cow lots of the fuel portion of food, — the carbohydrates, — and not that portion — the albuminoids — which is required to build up the tissues of the body in which the fuel is to be burned.

CHART NO. 4.

Composition of Bodies, in Percentages.

	Water.	Albuminoids.	Fat.	Ash.
Ox (half fattened), .	51.5	16.6	19.1	4.66
Ox (fat), ...	45.5	14.5	30.1	3.92
Sheep (lean), . . .	57.3	14.8	18.7	3.16
Sheep (fat), . . .	43.4	12.2	35.6	2.81
Swine (lean), . . .	55.1	13.7	23.3	2.67
Swine (fat), . . .	41.3	10.9	42.2	1.65

I give you on this chart an illustration of the composition of the animal bodies, showing the average composition of a cow. The body is more than half composed of water, one-sixth of albuminoids, one-fifth of fat and one-twentieth of ash. You can see at a glance that a cow to be fed well must receive in her food certain proportions of these substances, or substances which can readily be changed into these in the process of digestion and assimilation.

In the case of milking cows, as was stated in the lecture by Professor Whitcher yesterday, a quantity of albuminoids is required, equal to about two and a quarter or two pounds per fourteen pounds of carbohydrates, and four-tenths of a pound of fat. We have found in our work, what most American investigators have found, that in this country a cow ought to have rather less albuminoids and rather more carbohydrates than the German standards call for; and therefore in making rations for feeding cows economically, we make them in that proportion.

The object I had in taking this chart of a cow — the least attractive of all my cow charts — was that I might escape anything that would stir up the feeling that ends in what is called "the battle of breeds" among farmers. I was sorry I did not have the very first crude sketch of a cow I ever drew for public use, or I would have brought that. It had a clear outline only of the typical dairy form of body. When I lectured in other places, after describing the qualities of the cow, from the very flimsy outline of her body, a farmer in the audience would say, "I am glad to hear you recommend the Ayrshire," — and I had not used the word in connection with the address. Another would say, "I am glad you favor the Jersey; that is the cow, after all." Others would tell me that I was in favor of the Guernsey or Shorthorn or Holstein; and all from my remarks on that non-committal chart. It was the best kind of a cow chart I ever carried, because it made each man see something of value that he liked in it; whereas, if I took a likeness of a Holstein cow that I might explain from it, I fear the men who owned Jerseys would not be in a receptive mood. I am not going to talk about breeds at all, but talk about the cow as a milking animal, and speak of two organs which are largely concerned in the profit which each may yield to the man who feeds her.

The first organ is her skin. All cows have that, and it is of similar value in all breeds. It is the most important organ of a cow, and is important for its function of digestion. The skin illustrates what I call constitution. We often hear people say such an animal or such an individual has a good constitution; and when you have said that in praise of an animal, you have said a great deal. What do you mean by a good constitution? When I speak of it, I mean ability to continue in good health, to perform all the functions of life and to render good service. It is the sum total of all the organs in their capacities and in their harmonious action. That is constitution. But go away back to the time when all that existed of the cow was a skin, filled with protoplasm — nothing but that. Take the very beginnings of cow life, and you have a very small *ovum* (Latin for egg), one cell and one skin. Then the cells multiply and are arranged in the form of a tiny globe. Inside of those cells is protoplasm, and by and by there comes an indentation of one side of the circumference of cells. The indentation grows deeper and deeper, until you have from what was originally one cell the skin of cells going all around the embryo and extending in a channel through the embryo. That becomes the skin of a cow after she is full grown, and the same skin goes around the body and through the body from the mouth through the bowels. The stomach of the cow is merely an enlargement of part of the channel of the inside skin. That is what I mean by saying the skin is a very important organ both inside and outside. It is the organ of digestion. The condition of the skin outside has much to do with the activity of the skin inside. If a cow is put into a stable where an effort is made, or a condition without an effort exists, for feeding her on chaff, through the skin along her back, the skin inside her stomach will be in a very poor condition for aiding in active digestion. Why do you suppose a man curries a race horse? He does it because he puts the outside skin in such a wholesome condition that the inside skin digests food better; and that is why a man should curry a cow. If a man wants to feed a cow for profit, he should use a curry comb or a brush over her skin every day. It is the best tonic you can use on a cow, — as well as on a man.

I will not follow that point further. The skin is a most important organ, and its outside condition has much to do with the profit derived from the feed the cow swallows. This treatment of the skin also has an effect upon the condition of young calves.

Of course many of these things you know already, but some of you may not know that when a cow swallows bulky, coarse food, it goes into her first stomach, and then goes back into her mouth to be chewed as her cud. I dare say that plenty of men who make their living from feeding cows have spent hours on a box in a grocery store, discussing politics, to one minute they have spent in watching and studying a cow as she feeds. It pays men best to look after their own business first, and make the country prosperous through their own prosperity; thus they help on the general prosperity of the community. A man cannot feed a cow properly unless he sometimes watches her eat, and chew her cud. A man who feeds a cow without an intelligent understanding of her digestive capacity, sees no meaning in rumination, — rumen being the name of the cow's first stomach. The point I want to make now is, that the cow floats the coarse food back into her mouth, and if you watch her you will see her swallow the water by squeezing it out of the cud. Then she will chew the cud forty, fifty or sixty times, according to the nature of the food she swallowed, and then send it on into the third and fourth stomachs for digestion, and thence on through the bowels. Now, if a cow gets any kind of food that goes into the third and fourth stomachs without going through the first stomach and being re-chewed, she cannot very well digest that food properly. The process of rumination is necessary for complete digestion. That is why I think all that a cow gets should be given in such a form that it must necessarily go into her first stomach.

A cow should have succulent food and lots of water. The stomach of a cow will hold about one hundred pounds of water, to be there all the time as in a mash tub in which she will soak the food herself in the best way. If a cow does not have abundance of water to drink, she cannot prepare her own food for digestion perfectly; and one means of profit is to give the cow succulent food, and then plenty of water besides.

That leads me to say this also, that we should give food in such a form as will both preserve and promote the health of the cow, and furnish all the material out of which increase or product may be built, and also stimulate her organs to activity. I am not afraid of using stimulants in my cow stable, or anywhere else; but I would not give my cows any Scotch whiskey to drink, nor do I think it would be good for men to swallow much of that stimulant either. But there are many useful, safe stimulants. Let me mention one. If you will put turnips and wheat straw together, you can winter dry cows on that in capital condition, because you have a stimulant in the roots and the bulky fodder which seems to act on the whole interior canal, and makes the organs of digestion and absorption work more actively. What do we mean by saying the organs are sluggish? In such a condition you may run food through them by the ton, and if the organs are sluggish, it will not be profitable. But if you stimulate them into activity they will appropriate nourishment from the food that is swallowed. The food for cows should be nutritious, bulky, juicy, stimulating and cheap.

I have occasion to speak of one other organ of the cow. I am confining myself to those two organs that are most affected in the feeding of a cow for milk. I have here a rough diagram, a sectional view, of a half of the cow's udder. The udder lies in two glands, as my two hands are placed now. You can take them apart, each one complete in itself, each one having two teats, and sometimes having three. As far as I know there is no circulation between the two glands, but there is circulation between the two quarters of one gland. Beginning at the bottom of the cow's teat and carrying the investigation upwards, we come to a valve which the cow seems to work as you would the mouth of a cotton bag or tobacco pouch. If you pull the strings running in opposite ways through its hem you close the mouth of it. A cow by the contraction of muscles here can close the valve, and when that valve is closed she is holding up her milk. The only key that will unlock this door of the cow's udder is the key of gentleness and kindness. The more unkindly you use a cow, the more she holds her milk up.

The blood from the artery comes in at the top of the glands and spreads all through. The arteries branch and meet the milk tubes, so they are all interlaced. The water in the cow's blood seems to pass through the cellular wall and go inside, so that the identical water which is swallowed by a cow passes through the cow's system out of her teats into the milk pail. That is one reason why, especially in the case of farmers who are occupied in supplying milk for table use, the very greatest care should be exercised to see that the water for the cows is pure and wholesome, — just as clean as the water you would drink yourselves. The inside of the lobes at the end of the milk ducts is lined with tiny cells, and you will get an illustration of what they are like under the microscope by thinking of the top of a honeycomb, each little cell covered over. The whole interior of the milk ducts is like that, only on a much smaller scale. When a cow is secreting her milk, the end of each of these cells seems to enlarge into a little bud, and when the bud is fully formed it drops off; and these make the fat-globules that trickle off and come down in the milk. That is why the strippings are richer than the fore milk of the cow, because these globules, being solid, and only in suspension in the milk, come down less easily and quickly than the fluid portion. You see it is not easy to pour rich food into the mouth of the cow, have it go all through that mysterious process of digestion, have it go into the blood of the cow, and then come down through this gland called the udder, form these little globules of fat, and have a response in richer milk in two days after you have fed the richer feed at the mouth. We do that all right in a flour mill or with some piece of machinery, which is not a living organism like a cow. The quality of a cow's milk depends upon the structure of the cow's udder. Good food will increase the activity of this udder's action, and poor food will decrease its activity. Its activity will always be in proportion to the nature of the material supplied in the blood, that material out of which milk is made; therefore the largest possible supply of the best quality of material should be furnished. If you lessen the supply of material and energy, you reduce the quantity, but the quality as to percentage of constituents cannot be speedily, permanently changed.

On our side of the line I have found many farmers who a few years ago fed cows in a most extravagant and wasteful way, because they thought particularly rich food would make specially rich milk; but when a man follows such a practice he gets no adequate return.

A few years ago I conducted an experiment to discover the influence and effect upon the quality of milk, as to its composition, by giving the animals rich food in one case, and what is commonly called poor food, in regard to its constituents or nutritive ratio, in another case. I will give you an illustration of our work with the three pens which I hold in my hand, that will save me some talking and you some questioning. I selected twenty-five cows and put them in three groups, dividing them as evenly, as to weight, breed and length of time since calving, as I possibly could. We had a Holstein, Shorthorn, Ayrshire, a Quebec Jersey and a grade Shorthorn in one group, and then we had these breeds represented in each of the other two groups. After a cow calved in one group she got a ration composed of forty pounds of corn ensilage, thirty-five pounds of roots and five pounds of straw. That was the fodder part of her ration,— a rather weak but very succulent ration. To that was added four pounds of meal made from a mixture of barley, oats, wheat and pease ground together.

The cows in another group of similar breeds, and as near as possible of equal weights, received the same fodder ration, with seven pounds of meal per day. The meal was weighed separately, so that they got exactly what I mentioned. Of the rough or coarser portion of the ration they were given all that they cared to consume. With respect to the third group of cows, it was arranged that when each cow "came in" she received the same fodder ration and four pounds of meal per day, beginning where the first group stayed all the time. After the lapse of two weeks the amount of meal was increased to five pounds per day for two weeks; at the end of that period it was increased to six pounds of meal per day, — a progressive increase in the quantity of meal each fortnight. One group of cows was on a low-grade ration, one on a high-grade ration, and the third received a ration of progressively richer quality. The experiment was continued until the cows of the third group obtained twelve pounds of meal per head per day. We have conducted over twenty thousand single tests of milk. We have not based our conclusions on imperfect data. In those twenty thousand tests the milk was in every case tested morning and evening, except on Sundays, and I did not find any greater increase in the percentage of solids in the milk of the cows receiving the progressive ration than I did in the milk of the cows of the other two groups. The conclusion I draw is, that if a cow gets a succulent ration and not more than six pounds of meal per day, she will produce as good milk as the cow fed on the richer ration I have mentioned.

My experiments lead to the conclusion that most cows are up to the limit of their capacity for richness of milk, but that few of them are up to their capacity in quantity of milk. Many cows can be fed with more meal, by which the quantity of milk can be increased; but in the case of the cows at our farm, I think they are almost all at their limit of capacity for percentage of solids.

The object was not to carry out a fad, but for this purpose alone, that I believed, and believe now, that you cannot in our country feed more than six or seven pounds of grain per day with any profit to the average cow. I can make a cow eat far more than that, and I wanted to show the farmers they would not get any richer milk. I carried out the test, and found that with these richer rations I got a larger quantity of milk, and more butter per day; but after I got past seven pounds of meal per head the limit of profit was reached. I got more butter, but at increased cost; and I would rather have less butter and more profit.

I regard twenty-two cents a pound as the price of butter to predicate the price on. We do not get as much for our butter in certain seasons of the year as you do here; but we do not have to pay quite so much for our feed, and the one balances the other.

I must not forget to say, in this connection, that in handling cows it is possible to develop the milk glands, the udder, in a large measure by treatment previous to the time when a cow begins to give milk. We had one remarkable heifer in our stable last winter, who was giving about three teacups full of milk a day a full year before she had her first calf. The udders of our heifers are rubbed systematically for three months before they come in; and that develops the milk-secreting cells, so that heifers will give more milk the first year; and if they give more milk the first year, you can enlarge production from that foundation just as well as you can enlarge from a smaller one. The rubbing of the udder of the heifer makes a remarkable difference in her milking capacity. It should be done every day, only a few minutes at a time. When our heifers come in the first time they have a tendency to dry up after milking about six months; but by persevering and insisting on the heifer giving milk for ten months the first year, you will fix the habit in that animal, to which she will afterwards adhere.

I pass on to say a few words on the preparation for summer feeding, and I may very well omit a good deal I had thought of saying on this subject, because I learn that you feed your cows here mostly in the stable in summer and in winter. I agree with those who said in the discussion yesterday that herds grass or timothy is one of the poorest kinds of hay for the production of milk. I would rather give the common salt marsh hay, so called, ton for ton, than pure timothy or herds grass.

Then we find that in seeding for hay and pastures it pays to add a large proportion of clover to the grass seed, and we sow it to the extent of eight pounds per acre. We find that alfalfa is one of the excellent clovers. Grass is a model food for cows, but since you do not generally practise pasturing here, I will pass over that part of the subject with only a few remarks. Grass is a model food for cows in regard to composition and in regard to the condition of constituents; and when it fails you should try to supplement it with a crop of mixed cereals, such as oats, barley, wheat, peas and horse beans, because you cannot get more than five months of good pasturing in the year in this latitude. In seeding down for pastures, our botanist recommends the use of June grass as the foundation or stock grass; to that he adds two pounds of meadow fescue, two pounds of orchard grass, one pound of red top, two pounds of common red clover, two pounds of alsike clover, two pounds of alfalfa and two pounds of white Dutch clover. In this way we get a much larger yield of food per acre than by sowing any one single grass. These come into good pasturing condition at different times, so that the pastures give a fresh bite to the cows for a longer period. In the management of pastures we find advantage from having the cows changed from one field to another from time to time. If one could pasture his cows in one field for a week and then give it a few weeks' rest by changing them to another field, he would get better results in his cows and better results in his fields than by having his cows roam over one field all the time. It is necessary to let cows have access to plenty of pure water, and there is a great gain in letting cows eat salt once every day. I made a test at one time with a herd of cows by which I deprived part of them of salt for two weeks at a time; and I found a loss of milk of about fourteen per cent on the average where the cows received no salt for two weeks. I found the milk would turn sour quicker in the same temperature than the milk from cows in the same fields, treated the same in every way except in the matter of access to salt. In summer time cows will lick all the way from two ounces to four ounces a day. I do not advocate the leaving of rock salt in the pastures, because I think the cows would satisfy their tongues before they satisfied their stomachs; so I put down a box of ordinary coarse salt, and the cows lick that as often as they want it. A cow will not hurt herself in that way by taking too much.

In connection with pasturing cows we have to do some supplemental feeding in order that the cows may be kept from shrinking in hot weather when pastures are apt to become bare and dry. For supplemental feed we find nothing earlier than winter rye, but it is not a very nutritious food, and it is not a feed that can be fed green for a long time, or that cows like very well; so I prefer to supplement with mixed cereals, oats, peas, barley and horse beans, combining the four in equal quantity, sowing one bushel of each per acre, and cutting and feeding when the grain is in the milk. In the last four years we have used these cereals; and I find the mixture gives the best results, putting all four together on the same field. I find spring rye also good food, but that lasts only a short period, and now we grow spring rye to get good bedding for our cows and good feed for our swine. Other crops will be necessary, but spring rye is excellent for these purposes and should be sown very early.

There is not very much difference in appearance or quality between winter rye and spring rye. I do not know as there is any difference in regard to the yield. I should not feed rye grain at all to cows. I have had no experience in the matter, but it is complained of as being a cause of abortion. I have not fed it to our cows, but have fed it to our swine. I find corn ensilage to be the best and cheapest feed for summer. This fall when we filled our silos we had twenty-five tons of corn ensilage left over after feeding our cows all summer. I do not find any supplemental food in point of cheapness and efficiency that compares favorably with corn ensilage for feeding in July, August and early September. We save labor by that practice. On an ordinary farm it costs a good deal to go to the field daily for green feed in the summer time. You can get no crop to yield so large an amount of nutrients per acre as Indian corn, or with less labor; and cows relish corn ensilage for summer feed. When the pastures are dry we keep the cows in during the day time. They escape the torment of flies, and can get the necessary exercise in the evenings and during the nights. They are fed corn ensilage in the morning and again in the evening before being turned out. I find that method the most economical way of eking out the pastures. We have fed corn direct from the field as early as July and August, but, as I shall show you in a moment, it is not economical to do so much before the last of August.

We cut the corn when we put it in the silo. Let me say one or two words about the silo; and I shall show you a sample of ensilage when I get through. We have found the silo a valuable ally, and a means of making money from dairy farming to such an extent that we cannot do without it at all under the present keen competition. A while ago, when the fierce competition did not touch us so keenly, we could afford to feed in a careless way; but now, under the stress of competitions from all quarters, we find the silo one of our best economies. Ensilage has come to mean any kind of fodder preserved in a succulent and cured condition for feeding cattle. There is a good deal of confusion in the minds of farmers as to the functions of a silo and the usefulness and value of ensilage. If a man puts a poor leg of lamb into his pantry, he does not expect that the pantry will improve the leg of lamb, — not very much; but I have known men who would put the poorest kind of weak, watery fodder into a silo, and then marvel because the good Lord did not regenerate it into strong, nourishing feed, because it was put into a silo. A silo does not improve its contents. It is not meant for that. It is only meant to preserve what is put into it; and if it does that, it fulfils every function which pertains to it. I think a good many things become more palatable by being put into a silo; but a silo cannot add any nutrients to the fodder. If a man will grow corn broadcast, and get a great mass of watery, weak feed, he will find the silo and such ensilage a very expensive way of watering his cattle; but if he puts into the silo suitable materials which will resist fermentation, then he will get ensilage of the best quality to feed to his cattle in the best way. We do not find silo building expensive in our country. The simple and essential requirements for a silo are strength, closeness, cheapness and durability. It should be sufficiently strong so the contents won't burst it. I would use just one-ply of lumber, put on horizontally in such a way as to make interlocking corners. I did build silos with four-ply of lumber and tar paper between them; and I could not keep the ensilage any better than with one-ply of lumber, tongued and grooved or planed on the edges.

We use pine and sometimes hemlock, and in some places spruce. One-ply of lumber lasts longer than two. There is less decay. Many of our silos last five years and longer. I examined one last year which had been built eight years, and I could not find a decayed place in the lumber. When it is filled with ensilage it does not rot quickly, but if the lumber is alternately wet and dry it rots quickly.

As the result of our climate, we find feeding in the stable to be necessary for six months of the year. In the stable the very first requisite is cleanliness. If a cow lives in a filthy stable, it costs more to feed the cow than if she is kept clean. A cow should live in a light stable. Otherwise the feed will not make so much milk or so good milk, will not make so much increase of beef or so good beef, because light is one of the great purifiers in the world, and keeps down disease and the germs that make for ill health. I would have a stable kept warm; and in our country I would allow the question of ventilation to take care of itself. I am just bold enough to say that. I would keep the stable light and reasonably warm, and through the walls, doors and windows air will enter in sufficient quantity for the cows. We should make our stable-feeding productive and profitable by keeping the cows in milk during the winter season. We do that because milk brings a higher price from November to May than from May to November. We do that because we get the largest quantity of milk per cow per year by having the cows milked ten months or ten months and a half. We do that because we want our cows to give us calves, directed in capacity and tendency towards large production of milk.

I meet with an objection sometimes which I may meet here. "When a cow is kept in milk for ten months and a half in the year, isn't the cow made very weak?" I have known cows that were dry for six months, resting all winter, and they didn't gain enough strength to get up alone in the spring. Resting from their labors as milkers does not make them strong. But I never knew a cow that was milked all winter and decently fed, as she is almost sure to be, to be weak in the spring. Cows which are milked for a long season are the stronger and give you calves having habits like their own, with a large flow of milk every month. Then milking during the winter months provides employment for the farmers and farm helpers, and that profitable employment during the winter is one of the most important achievements in farm management to-day. I do not know how seriously it affects you down here. I will take time to suggest one illustration. I can think of a boy living on a farm, who, after putting in a real hard day at exhausting work binding grain or pitching hay, would come home without any fear of meeting anybody on the road, — not feeling that he wanted to shrink away out of sight and apologize for the condition of his person or of his clothes. I have watched that same boy, proud, manly, self-possessed, modest, noble and strong, — typical of the boy who lives on the farm on both sides of the boundary line, the boy who does all of his work well. I have seen the same boy, when he had nothing to do on the farm except to idle at the unremunerative chores all winter. When anybody would come to see him then, his manliness had shrunken and he would skulk to the barn and pretend that he was busy, to nurse into life the high quality of self-respect that comes from being usefully diligent. Farmers should provide paying employment for themselves and their men and their boys during the winter, through the manufacturing into milk, bacon, etc., of the primitive products obtained from their fields in summer.

Then, having cows milking in the winter, how shall we grow crops to cost ourselves the least for the milk we get back from them? Indian corn is perhaps the best crop of the continent for that purpose. It is a sun plant, a great accumulator of energy, a great conserver of energy for the farmers of this whole land. I would like to tell you of what magnificent, what stupendous service is rendered to mankind by corn plants, but knowledge and language alike fail me. They enable man to realize upon the powers of sun and air for his own service.

The air is the other storehouse of plant food. Between ninety-two and ninety-eight per cent of all the substances of plants comes from the air. The man who farms well will have his plants grow a suitable distance apart, as far as practicable, in order that the air may circulate freely and the sun shine in brightly, that the plants may get from the air the food it contains for them. This is one reason why it does not pay a man to grow a crop of broadcast corn; the stalks are so close together that there is not enough circulation, the plants have less vigor and the soil becomes exhausted.

The spring in my watch is merely what the plant food is in the soil. The spring is a contrivance into which I store my own strength; the plant food is a convenience into which the sun can store his strength, his energy. And then, when a horse eats a bundle of hay, he is merely transferring into horse-power the power which the sun rolled into that peculiar plant-spring. In that way the sun is doing all the work of the world. A long time ago the sun was shining down on the earth, hotly, vigorously and continuously. He was rolling himself up, year by year and century by century, into plants, — plants that stored his strength with avidity. Then there came great changes in nature, and those big trees and plants, full of the sun's energy, were buried away down deep in the bowels of the earth; but still they held the sun's strength. Men open mines, they dig up concrete sunshine and energy in the form of coal; the furnace is filled; the magic liberator — fire — is applied; and as the mighty engine moves, wheels are turned to-day with the energy which the sun wound up in the vegetable kingdom of the earth ages and ages ago.

The man who furnishes in the soil no plant-food for the young plant keeps the sun idling on his field all the day long. So a man ought to make it his pleasure, as it is his privilege, to harness the old sun every day in his farm work, and make it do his will by making it roll its strength into such plants as he wants for his service. Now, a man could never afford to hire half a dozen men on a farm and have them "loaf" all day long, while he is wearing himself out with working. But the man who wears himself out with working and keeps the sun idling all day long is doing a far more foolish thing. So a man should recognize that he has the right — that he has the power — to control the sun's working, make it work upon his fields, and thus save himself from the reproach of leaving the best working power in the world idling on his place. The farmer requires skill, he needs knowledge, he must have above all things good judgment, in order that he may fitly control and exercise the power placed at his command.

Let me show you what all this means, practically, in dairy farming. The man who farms successfully and skilfully in dairy farming will always have abundance of plant food in his soil, and therefore he will keep the sun working for him by giving the sun the raw material out of which to build plants. If the sun be deprived of that, he does not intend — using the word figuratively — to work; he will not make bricks for any man without clay. There are men who are all the while running counter to these old foundation laws that were made for agriculturists. One man thinks that it makes no difference how much sunshine he has, or how little. It makes all the difference in the world.

The sun exerts great energy on the earth all the time; some of that energy is stored in the corn stalks, and that is the most economical channel through which this energy can be obtained for the feeding of cows.

It is a hard task to feed a cow successfully, and I am glad it is. I do not want to do the easy jobs that any man can do. I am glad that dairy farming is difficult. I am glad that all farming is hard to do, and that it is at least a little bit hard to make money from farms. If it were easy, it would take a low grade of men to do it, and then you and I would just stay at that low grade; but because it is difficult, the people of these New England States have done for this country what Scotland has done for the world. You have fertilized it with energy and ingenuity and intelligence, because you have had to wrest what you have gotten from adverse circumstances, qualifying yourselves to do things which are hard to do, but which make you better men for the doing of them. When a man begins to think of getting the mastery in agriculture, and does it modestly, the more of real mastery for the service of his fellows comes into his life.

Now, this corn plant which is stored full of sunshine, put in the soil, will keep on accumulating, and this chart is to show you the rate of accumulation at certain stages of its growth, taken from a comparatively large number of experiments.

CHART NO. 5.

Indian Corn, Yields per Acre.

Tasselled, July 30: —	
Green weight (pounds),	18,045
Water (pounds),	16,426
Dry matter (pounds),	1,619
Silked, August 9: —	
Green weight (pounds),	25,745
Water (pounds),	22,666
Dry matter (pounds),	3,079
In milk, August 21: —	
Green weight (pounds),	32,650
Water (pounds),	27,957
Dry matter (pounds),	4,693
Glazed, September 7: —	
Green weight (pounds),	32,295
Water (pounds),	25,093
Dry matter (pounds),	7,202
Ripe, September 23: —	
Green weight (pounds),	28,460
Water (pounds),	20,542
Dry matter (pounds),	7,918

We cannot get these substances containing dry matter anywhere else as cheaply as through the corn stalk and put them into money values, and if the crop for feeding purposes is worth sixteen dollars at the tasselling stage the same crop is worth seventy-two dollars for feeding at the glazed stage of growth. That is why we cannot afford to cut Indian corn stalks at the tasselling stage and feed them to our cows in the summer instead of pasture. It does not pay to cut a corn stalk down at the early stage of its growth. It is like cutting a man off when he is twenty-five years old; because if a man is worth anything to anybody at that age, he is worth much more when he is older, — he should keep on doing more and doing better as he develops and matures. Corn should be cut at the glazing stage, when the corn kernels have passed out of the doughy stage. We wait until the lower leaves are yellow, and the corn is ready for the silo at that time.

In talking of dry matter, not only is the dry matter more plentiful by the acre at the later stage of growth, but it is worth more by the ton.

One thing more in this connection. This is taken from an average of five trials, and part of my information was taken from the experiment station in New York. This is in the line of the last chart I showed you, showing the progressive increase of nutrients per acre.

Chart No. 6.

Comparison of Nutrients per Acre, at Different Stages of Growth, of Indian Corn.

Tasselled to bloom, July 24 to August 5 : —	
Dry matter (inches),	10
Albuminoids (inches),	10
Fat (inches),	10
Carbohydrates (inches),	10
Glazed to ripe, September 3 to September 23 : —	
Dry matter (inches),	30.5
Albuminoids (inches),	21.4
Fat (inches),	33.0
Carbohydrates (inches),	36.5

If the quantity of dry matter per acre at the stage of growth known as "tasselled" be represented by 10, then the quantity of dry matter in the same crop when it reaches the stage "glazed to ripe" will be represented by 30.5. The increase of the albuminoids is in the proportion of 10 to 21.4, of the fat in the proportion of 10 to 33, and of the carbohydrates in the proportion of 10 to 36.5.

As large a percentage of this is digested as of that cut at the earlier stage. And there is this decided gain, that when any plant in a rather immature state is put into the silo it is liable to become very sour, and pass into decomposition. If the same plant is allowed to come nearer to ripeness, it is much more robust, and comes out of the silo in a wholesome condition for cattle.

Now, while corn is an excellent food, it is not in itself a complete food. It does not contain enough albuminoids in proportion to the carbohydrates it does contain, therefore we must find other crops to put with the corn to get the best result. Many other crops get nitrogen or albuminoids from the land or air, and therefore contain it in themselves. You might put them with Indian corn as ensilage or fodder, and get good results from the combination.

CHART NO. 7.

Nitrogen, Phosphoric Acid and Potash in One Ton Each.

Wheat: —		
	Nitrogen,	41.6 lbs.
	Phosphoric acid,	15.6 "
	Potash,	10.4 "
Barley: —		
	Nitrogen,	32.0 "
	Phosphoric acid,	15.4 "
	Potash,	9.0 "
Oats: —		
	Nitrogen,	38.4 "
	Phosphoric acid,	12.4 "
	Potash,	8.8 "
Peas: —		
	Nitrogen,	70.6 "
	Phosphoric acid,	17.2 "
	Potash,	19.6 "
Beans: —		
	Nitrogen,	81.6 "
	Phosphoric acid,	23.8 "
	Potash,	26.2 "
Indian corn: —		
	Nitrogen,	32.0 "
	Phosphoric acid,	11.8 "
	Potash,	7.4 "
Hay: —		
	Nitrogen,	31.0 "
	Phosphoric acid,	8.2 "
	Potash,	26.4 "
Clover: —		
	Nitrogen,	39.4 lbs.
	Phosphoric acid,	11.2 "
	Potash,	36.8 "
Potatoes: —		
	Nitrogen,	6.8 "
	Phosphoric acid,	3.2 "
	Potash,	11.4 "
Fat cattle (alive): —		
	Nitrogen,	50.0 "
	Phosphoric acid,	31.2 "
	Potash,	2.8 "
Fat sheep (alive): —		
	Nitrogen,	44.0 "
	Phosphoric acid,	22.6 "
	Potash,	2.8 "
Fat swine (alive): —		
	Nitrogen,	34.8 "
	Phosphoric acid,	14.6 "
	Potash,	2.0 "
Cheese: —		
	Nitrogen,	90.0 "
	Phosphoric acid,	23.0 "
	Potash,	5.0 "
Milk: —		
	Nitrogen,	10.2 "
	Phosphoric acid,	3.4 "
	Potash,	3.0 "
Fine butter: —		
	Potash,	0.5 "

In dairying we can protect the soil as well as feed the cow, because when wheat is grown and fed to cows, if butter only is sold, it carries off only an infinitesimally small portion of nitrogen from the farm. A ton of hay will carry off from the farm as much of the elements of fertility as eighty-seven tons of butter.

But these crops, especially peas and beans, added to the corn, will enable the farmer to get the best combination for his cows, and the manure going back on his fields will keep them from being impoverished. That is only leading up to another chart. In getting these crops from the land and feeding them to cattle, and putting the manure back on the field again, in every ton of manure you have about seven pounds of nitrogen, three pounds of phosphoric acid and eight pounds of potash.

CHART NO. 8.

Chemical Composition of Manures (Pounds in a Ton).

		Nitrogen.	Phosphoric Acid.	Potash.
Cattle:	whole,	7	3	8
	liquid,	12	.12	10
	solid,	3	3	2
Swine:	whole,	9	4	12
	liquid,	9	1	17
	solid,	12	7	5
Mixed farm manure:	fresh,	9	4	10
	rotted,	11	6	10

This chart confirms the teachings of the lecturer this morning, — that in dairy farming it pays to look after the liquid voidings of the animals, because often the liquid voidings contain the largest portion of valuable constituents of food plants. This chart is used merely to show you that by raising these crops and putting them with corn you get the manure put back on the land again, and renew the fertility.

I have spoken of using, as far as we could, some plant that will entangle the nitrogen, and give us the albuminoids required for feeding cows at the lowest possible cost to ourselves; and I have put on the next chart the nutrients per acre that can be obtained from certain crops which I think are the best that can be grown for feeding cows summer and winter; and this is, as far as my talk to-day is concerned, the conclusion of the whole matter. If I were running a dairy farm down here and could grow these crops, I would grow them mainly to feed my cows at the very lowest cost to myself, and to protect the soil.

CHART NO. 9.

Quantities of Nutrients per Acre.

	Albuminoids (Pounds).	Carbohydrates (Pounds).	Fats.
Indian corn (9,000 pounds dry matter), ...	873	7,371	288
Horse beans (12 tons, green), . .	653	1,814	167
Sunflower heads (7½ tons), . .	352	2,373	729
Hay (mixed, 2 tons),. . . .	271	2,888	97
Roots (carrots or mangels, 20 tons),	480	4,320	68

I will speak a moment of horse beans. I do not know that that plant is well known here. It ought to grow here, because the soil is similar to ours, and your climate is similar to ours. The horse bean is a plant with a square stem as thick as my little finger, growing four or five feet in height, and with pods on the sides. We grew that crop last year, planting two-thirds of a bushel to the acre. We cut nearly thirteen tons of green fodder per acre. We grow it in rows three feet apart, like corn. It was grown quite largely last year on our side to mix with corn to make ensilage. We on our side have been compelled mainly to look after reducing the cost of these things. By the introduction of machinery, as well as by the stress of competition from elsewhere, our farmers have been compelled to try to reduce the cost of their products, and this is one means whereby we have been able to reduce the cost of feeding our cows a great deal. An analysis of horse beans gives six hundred and fifty-three pounds of albuminoids per acre, and I think the largest proportion is obtained by the horse beans taking nitrogen from the atmosphere direct. We are making the bean plant an agent for enriching the land and feeding our cows at the same time. Now, we need something besides corn stalks and beans. In our climate we find the cattle doing better when they have rather more oil in their feed than we have been able to give them in corn and beans.

The experiments which have been conducted in Germany have been most thorough, accurate and reliable; but then the Germans have not a climate like ours. Living in a cold climate, our cows may need a greater quantity of oil or fat in their feed; and so I began to grow sunflowers for cattle feeding. We have grown six and a half acres this last year. Our cattle relish them keenly, and they give a delightful flavor to the milk and butter. We have been able to obtain 729 pounds of fat to the acre in this crop, in a very cheap form, because we can grow sunflowers at a cost of $20.09 an acre for labor. Then on the chart I have put mixed hay. I need not speak of that; and I have added roots, carrots and mangels, because we can feed these two roots without injuring the flavor of the milk. I put them at twenty tons to the acre, although our actual crop was twenty-two tons of one and twenty-three of the other. In this combination and growing this class of fodders, which have all three of these nutrients — albuminoids, carbohydrates and fats — in the proper proportion, we get the bulk that is needed. The cow is an animal with a large stomach, and if you cause any cow to become small of belly, she comes to have a small udder. I find the two go together; and cattle that have an enormously large belly will often have a very large milk gland, therefore I want bulky feed. If I could get the same quantity of nutrients in less bulk, I would prefer the larger bulk. I want cow feed that is juicy. I do not want to have it dry if I can help it. Juicy feed is best, and those feeds are best which are kept juicy in the natural state.

Question. Then you would prefer green apples to apple pomace?

Professor Robertson. No. Apple pomace is worth more than green apples per one hundred pounds for feeding cattle. I am speaking now of the effect on the digestive system. Counting the expense for growing corn at $1.25 a day for the laborer, $2.50 for a team and man and $3 an acre for the rent of the land, and counting every dollar of cost of the crop at those rates, our corn cost this last year $20 an acre for getting a crop into the silo, counting nothing for the exhaustion of the land or for management. Then our horse beans have cost $25 an acre, sunflower heads have cost $20.09, and hay I estimated at $8 an acre; the roots cost $30 an acre. Adding the cost of growing these crops and having them in the silo or ready to feed the cows, I find a cost of $103 for the crops from five acres; and that food is just as cheap, so far as feeding value is concerned, as though you had hay for $5.50 a ton, as though you had wheat at 28 cents a bushel, as though you had barley at 23 cents a bushel, as though you had Indian corn grain at 22 cents a bushel, as though you had oats at 16 cents a bushel. I would rather feed the bulky fodders from the five acres, as far as the effect on the health of the animal is concerned, than the equivalent nutrients in the grains I have mentioned at the prices I have named. This is how we feed our cows to get the best results: 50 pounds of this mixed ensilage, 25 pounds of roots (for the sake of the stimulating influence), 5 pounds of hay and 5 pounds of mixed meal (1 pound each of barley, wheat, oats, wheat bran and linseed meal). That on the whole makes an excellent ration at a cost of 12 to 14 cents per cow per day.

Question. What is the average product?

Professor Robertson. That depends on the cow. Some cows will give a large yield of milk, which do not eat any more than others that give a small yield of milk. That is not the point. I find that I cannot by any quantity of food make some cows give as much milk as others which take less feed. We have had cows that have given us all the way from 5,000 pounds of milk a year upwards. We have had none that went over 11,000 pounds and none down to 4,000 pounds. We cull the poor ones every year.

Question. Is this horse bean which you speak of suitable for drying and curing?

Professor Robertson. You cannot cure it easily, because the stalk is juicy and difficult of being dried, and so it is best preserved in the silo.

Question. Do you think it is a good thing to remove the horns from cows?

Professor Robertson. I have no objection to the practice, but I would rather see a cow with horns on. As we have our cows in the stable the most of the time, the horns do no damage. I would take the horns off a vicious bull without scruple. Horns are merely a weapon which the animal once needed, but does not require now. I believe in taking horns off, and were it not for the pain to the animal, I would take them all off. In the case of fattening steers I would do it without scruple, because it prevents them from hurting each other.

Question. Do I understand you to say that you mix corn ensilage, horse beans and sunflower heads together and put them into the silo?

Professor Robertson. Yes; and we put the heads of the sunflowers in whole, to save the expense of cutting them. All I have tried to show to-day is to help men who follow farming and expect to make money from feeding cows, and who in most places should grow the bulk of the feed on their own farms; and in doing that they should keep in mind that it is possible to keep the land rich. I think you make the best use of cows by keeping the lands rich through their agency, making yourselves rich and industrious, and making yourselves wise and capable by the difficulties that meet you from day to day. As I said a moment ago, I am glad that dairy farming is a difficult vocation, because it will educate and elevate men to meet the responsibilities of life on this continent with all its marvellous duties and opportunities; therefore I am glad there are difficulties to be surmounted, because work that is hard to do will leave you better for having done it.

The Chairman. The subject of this afternoon and forenoon are both of them so wide in their reach that the speakers have found it necessary to occupy an unusually long time in covering them, but if the audience wishes to wait, there are a few minutes left, and if they will ask questions right to the point and as directly as possible, the professors will be most happy to answer them.

Question. I would like to inquire if feeding ensilage causes the approach of tuberculosis?

Professor ROBERTSON. I do not think so, because ensilage is a most wholesome ration, and puts animals in the best health; and good, vigorous health is the best preventive of that disease.

Professor WHITCHER. What would be the effect of corn ensilage fed to a brood mare in foal?

Professor ROBERTSON. I do not know; but I know some of our best breeders of horses have fed corn ensilage and horse beans to their colts with good results.

Professor BROOKS. In regard to the effect of ensilage upon tuberculosis, I am aware there is quite a general prejudice against it, many having the notion it has something to do with tuberculosis. The statement has been made that most colleges have tuberculosis; and that which I think was in the mind of the gentleman who asked the question, though not expressed, was that most of them feed ensilage. We have had tuberculosis at Amherst, but we have had it for over twenty years, and we never had a silo until the last few years. I think many others can relate a similar experience. I have no idea that ensilage has anything to do with tuberculosis. The first thing to do is to keep the cow in good health. If you feed a cow with sour ensilage, it is possible you may lower her health and make her an easier prey to tuberculosis, but if you feed it judiciously, I believe there is no possible connection.

There were one or two thoughts suggested by Professor Robertson's remarks which I may be pardoned for bringing forward. He referred to mixing oats, wheat, barley and peas. In many parts of Massachusetts it would not answer, I think, to sow spring wheat. Invariably in the Connecticut valley it rusts very seriously. That is one of the things worth thinking about.

Then, again, is there any economy in feeding ensilage in summer, rather than fodder? I do not think it is possible to feed cattle on whole corn stalks without a great deal of waste; a considerable part of the stalk will be left. You can undoubtedly starve them into eating the bulk of it up, but they won't give you a satisfactory return in milk, whereas if you make it into ensilage they will eat it all.

Then, taking the figures which he has given in comparison with the cost of other things, where is the economy in raising the horse bean? The question has been asked whether it has been tried here. Dr. Goessmann is in the audience, and he can answer the question a little more explicitly than I can. With all respect to Professor Robertson's opinion, if they cost as he states and give the return which he states, how can we afford to grow horse beans?

He says we ought to raise the precise materials which we feed. Those materials can be purchased, and the price of land, fertilizers and labor would all affect that question. I believe that in many instances we could buy the nitrogenous constituents of our food cheaper than we could raise them; so that, if horse beans are going to cost more to raise than corn fodder, and do not produce as much, I would prefer to buy the albuminoids in the shape of concentrated feed stuffs.

Then, as to roots, there have been a good many experiments carried out in Massachusetts and in other States, as to the economy of roots as compared with ensilage, and the result has been, as far as I know, against the roots. We cannot grow roots here to as good advantage as Professor Robertson can in Canada, because our labor is so much higher.

QUESTION. Have you tried scarlet clover?

Professor ROBERTSON. It did not stand over winter. Permit me to make one observation. I very well know that Indian corn by all odds is the best crop to grow for feeding cows, but the nutritive ratio is too wide between the albuminoids and carbohydrates in corn. I want to narrow that down, and I do that with horse beans, in which the nutritive ratio stands less than one to three and one half. I merely try to get the albuminoids with a small quantity of carbohydrates. If I could buy them cheaper than I could raise them, I would buy them; but on our side of the line, and perhaps on this side, I find many farmers have not a commercial talent for buying these things and feeding them at a profit. But they have a talent for growing them, so I prefer to raise the horse bean rather than buy albuminoids in other form. At the same time, other matters are very well pointed out by Professor Brooks, who is here with you and knows you, and knows how to give you the safest kind of good advice for your guidance; and I thought to-day, when Professor Brooks was giving his lecture on maintaining the fertility of the soil, that if we can get him up into our country we will have a reciprocity in professors of agriculture if not in agricultural products.

Secretary SESSIONS. The professor was requested to bring out this last proposition, how can we raise on our farms complete rations? Now, I want Dr. Goessmann to tell his experience with the horse bean, and when he is telling us that, if he has any suggestion to make about any other crop that he thinks would give us albuminoids more cheaply than horse beans, I would like to have him tell us.

Dr. GOESSMANN. We have experimented for a number of years at the Massachusetts State Agricultural Experiment Station with a variety of crops, including the horse bean, vetch and similar fodder plants. During the past season we raised twenty-seven varieties of fodder crops, more or less prominent in different parts of the world. Our object has been to study their fitness for our climate and soil. Some of these crops have already proved a valuable addition to our fodder supply. We have raised vetch and oats, barley and the horse bean, as mixed crops. These crops produce a liberal amount of fodder, from three to four tons of hay per acre. This hay is equal to the best clover hay we can raise. The advantages of these mixed crops are many. They yield a large supply of valuable fodder, they mature in a short time, can supply fodder in the form of green fodder or hay or ensilage, and have proved in every form a valuable supply of coarse fodder for dairy stock. When we consider that our average meadow does not produce more than one ton of hay and our better class scarcely more than two tons of hay per acre, it will be seen that a mixed crop of the kind I have mentioned produces from two to three times as much per acre as our meadows can produce, and a product which exceeds by fifty per cent, in the nutritive value, our better class of meadow hay. Besides these mixed crops which we can highly recommend to our farmers, we find that serradella produces from ten to eleven tons of green fodder of a large feed value. As to vetch, it comes in about a month later, and is well fitted for green fodder and ensilage. The horse bean we raise with good success and in satisfactory quantity, which convinces us that it can be raised with profit as an additional fodder crop either by itself or in connection with one or the other of our summer grains. The object of introducing crops like these into our farm practice is to reduce the necessity of buying commercial feed stuffs, and at the same time to improve the condition of the soil for a second crop in the same season at the expense of the nitrogen of the air, for these crops leave more nitrogen behind than the soil contained before. The question of introducing more prominently the leguminous plants into our system of raising forage crops deserves the serious attention of our farmers.

Secretary SESSIONS. When the professor speaks of the corn stalk, does he mean the whole plant, ear and stalk?

Professor ROBERTSON. Yes, sir; I mean the whole plant. And I want to add just one observation. I did not say much about the fact that we were growing the horse beans in mixed crops, but we have done that with much success. The horse bean, in growing with abundant pea or vetch vines, will hold the vines off the ground. This is the ultimate goal that I have in view, — to get a combination of ensilage that we can feed without adding anything to it at all. That will help to solve the problems of labor and the cost of stable feeding, and reduce them to their very lowest figures. And let me say this also. I have not had the pleasure of seeing Dr. Goessmann's face until to-day, but I have followed his work with much interest and profit to myself. I may say also that I discussed the matter of my lecture here at this time with the Minister of Agriculture in our Dominion some days before I left to come here. He said, "What are you going to do?" I said, "I am going to Massachusetts, which I consider one of the foremost States of the Union for agricultural thought and practice. I shall learn all I can, and bring back four times as much information as I give."

Mr. EVANS. I want to say one word in corroboration of the professor's method of building silos. From the first I adopted the system which the professor told about, and I have silos which have been built now eleven years, and I have not found an indication of decay in them. I think he is certainly correct when he says a single boarding is much more safe from decay than the double. I have found ensilage always kept perfectly in that way.

QUESTION. Do I understand there is an advantage in feeding from the silo in July?

Professor ROBERTSON. Well, we cannot get our crop of corn to the stage of growth fit for cutting by that time, so we feed from the corn crop of the previous year, out of the silo.

QUESTION. Do I understand you to say that the only advantage to be obtained in feeding from the silo, providing the corn in the field is in proper condition, is simply on account of the saving of labor?

Professor ROBERTSON. That is all. We do not find it possible to grow the kind of corn we like for ensilage to the right degree of maturity until September. As fast as our corn is fit to cut, we feed that direct from the field and fill the silo at the same time.

QUESTION. Is yellow corn superior to sweet corn?

Professor ROBERTSON. We have not found any difference by the ton in the various varieties. It is largely for the individual farmer to find how he can select a variety suited to the soil and climate where he lives. He can make sweet corn do better in some places than in others.

QUESTION. Did you ever try sweet corn?

Professor ROBERTSON. Oh, yes; a great many times.

QUESTION. What do you think of ensilage as a supplemental food? Does it hurt a cow? Is she poorer for it after two years than she would be without it? Is she hurt by it?

Professor ROBERTSON. I do not think so. I think if the ensilage be exceedingly sour (which it need not be) then it might hurt the cow.

QUESTION. Can you grow a crop of barley after cutting the corn?

Professor ROBERTSON. I have not found it possible to grow barley in the same season after corn. I have tried some crops after corn. I have not found it possible to grow many crops after corn. I would not sacrifice any of the original crop for the sake of a second crop.

Mr. ——. I have raised a full crop of barley and brought it to milk by the middle of September.

Professor ROBERTSON. We have had no weather to do that in Canada.

Secretary SESSIONS. That was a remarkable season.

Mr. BOWKER. I wish the professor would tell us something about how to grow sunflowers. How do you cultivate them? I ask that question because the sunflower seed might be used in this locality for other purpose than feeding cattle.

Professor ROBERTSON. We grow sunflowers to use in our feed rations. We sow five pounds of seed to the acre, because we cannot put on less without too much labor. We grow them like corn, in rows three feet apart, and leaving plants about eighteen inches apart in the rows. We cut them when they are ripe. We have had seven tons of heads from an acre.

Mr. BOWKER. What do you do with the stems?

Professor ROBERTSON. We burn them. We thought they would be of some value for fuel, but they are not worth much, although they are burned in some places for that purpose.

QUESTION. Has any one in this audience had any experience with scarlet clover in this latitude?

Mr. STETSON (of Lakeville). I was requested last spring to make an experiment, but the seed did not reach me from Washington until quite late in the season. I think I sowed it about the middle of May, and it came up very nicely, but dry weather came on and checked the growth. We had an extremely dry summer afterwards, and it never recovered. My impression is, from what I have learned since, that scarlet clover should be sown in August. I have had very good success with other clovers, always sowing them in the spring, the earlier the better. If I were going to sow common clover, I should sow it in March.

Professor BROOKS. We tried scarlet clover at the Experiment Station in Amherst, sowing in the spring one year, and got a good crop. That was on a very small scale. Then we tried it two years sowing in August. It made a very good start, but it was all killed during the winter. This was in good, well-drained land, as good land as any we could find in Amherst for the purpose. We have tried again this season, sowing a little earlier than last year, about the 20th of July; but this has been an extremely dry season. The plants are not as large as I would like to see them, and I very much fear that they will be killed this winter. I think crimson clover, as it is more commonly called, if sown in the spring, would not be much of an acquisition, because it would not give us a better crop than red clover; and, unless it will live through the winter, of which there is grave doubt, it will not, in my opinion, prove of much value.

I think alfalfa is more liable to be killed in the spring than it is in the winter. I think one reason why we cannot raise it here is because we have more freezing and thawing, while in Canada they have snow, which protects it until the weather becomes settled. The same is true in Japan. There we could grow almost anything, as the snow protected it. There was none of that rainy season, with freezing and thawing. I have now about an acre of alfalfa sown on a very high, sandy knoll. If alfalfa will live anywhere in Massachusetts it will live there. It made a good start, and on one field grew two feet in height, of pretty good weight to the acre the first year; but it received careful attention, — it had hand weeding and hand mowing. It would not pay to raise it, if it is going to be killed this winter or in the early spring; so I await with interest the arrival of next spring, to learn the condition of this crop.

Prof. J. W. SANBORN (of Lower Gilmanton, N. H.). I think the alfalfa or lucerne, as it is known in the arid regions, finds its best habitat in arid sections, where the subsoils are open and abound in potash and lime. It does not thrive on compact subsoils, such as we have in New England. I have known of ten tons per acre dry crop, while seven tons are common with three or four cuttings. I think we may as well dismiss all hope of making this crop a successful competitor of clover, for in this section it will be inferior to that crop. As a grazing crop it goes to stalk, which is often followed by death.

The CHAIRMAN. The time has now come when this meeting must close, and it will stand adjourned until to-morrow forenoon, at half-past nine o'clock.

On the evening of the second day a reception was tendered the Board of Agriculture by the Newburyport Board of Trade. The gathering was held in the Wolfe Tavern, and proved an exceedingly enjoyable occasion.

THIRD DAY.

The meeting was called to order by Vice-President GRINNELL, who said: Mr. C. L. HARTSHORN of Worcester, one of our oldest members, has consented to act as chairman of this meeting.

On assuming the chair Mr. HARTSHORN said: Mr President, ladies and gentlemen: I consider it an honor to be selected in this body of farmers and members of the State Board to preside over their deliberations, and thus relieve our very able vice-president. I have the pleasure of introducing Prof. J. W. SANBORN of Lower Gilmanton, N. H., who will speak upon "Comparison of eastern and western farming."

Prof. J. W. SANBORN. Mr. President, members of the Massachusetts Board of Agriculture and citizens of Massachusetts: It is with pleasure that I appear here for the second time before your Board of the State of Massachusetts, that grand old Commonwealth that we have all learned to honor and respect. I am obliged to the secretary for the courtesy and honor of the opportunity to be here to-day before you and to be with you. The secretary, in an hour when perhaps his judgment may have failed him, asked me to put in manuscript what I had to say, in order that he might publish it, and so I have stored up my energies this morning in this paper. I suppose I can unwind what I have to say easier from paper than in an off-hand talk, and can give you more in less time; so that, contrary to my usual practice, I shall read what I have to say to-day. I will say further in these introductory remarks that this paper does not consider the agriculture of the Pacific slope or mountain regions, including Utah, a region where everything is unique. There nature stands apart by itself, unlike nature anywhere else, and it seems to have stamped on the men and women who occupy it a difference from the men and women of other parts of the country, and not only on the men and women of the State, but on the social and civil and religious customs of the people, passing on still further into the agriculture of the people, until we find everything in Utah quite strange; but in this far-off world, removed a thousand miles from the other civilization in this country, the markets are home markets, not influencing our agriculture except remotely.

COMPARISON OF EASTERN AND WESTERN FARMING.

BY PROF. J W. SANBORN, LOWER GILMANTON, N. H.

The west is peopled by the stirring, ambitious sons and daughters of New England and the better sections of Europe. The pioneers and their descendants now occupying the great plains of the west are an energetic, broad-minded and generous class of men and women, altogether worthy of the age in all of its demands. As mind is more potent than matter in surmounting material conditions, the world may expect to find in the farmers of the great plains competitors altogether worthy of their energy and intelligence. The west of to-day is one of the finest fruits of the wondrous development of the applied sciences during the present generation. Had it not been for steam and steel, New England hills, sterile as they are, would have been one of the most densely populated and productive areas of the rural world. But the very forces that have been the source of the wealth and grandeur of the west have been and are the agricultural menace of that section.

The causes that lie at the root of the splendid growth of the west mark the broad distinction that exists between its agriculture and ours. There it is extensive agriculture, resting upon free fertility, machinery and boldness of operation. Here our agriculture is flattered by the term intensive, and is grounded to a larger degree in manual labor and timidity of operation. The former is an agriculture of tillage, the latter of grass. The former derives its crops from art more largely, and the latter from nature. Where tillage is involved, capital, labor and machinery are brought into play. Where grass is the main crop, these forces are relied upon in the minimum and nature in the maximum.

Of the entire area in Illinois devoted to the several grain crops, corn and hay, although the percentage of hay ground has been increasing for a decade, 80.8 per cent are yearly ploughed, leaving only 19.2 per cent annually mown. The area to grain, corn and potatoes was 14,811,871 acres, while that mown was but 3,522,884 acres. The practice of Illinois in this respect is the practice of other western States.

In Massachusetts the area devoted to the several grain crops, corn and potatoes, is 82,711 acres, while that given over to the grass crop for mowing is 627,385 acres; or only 11.6 per cent of the arable area is under annual tillage, 88.4 per cent being in hay fields. What is true of Massachusetts in this regard is true of the rest of New England.

Two broad and markedly distinct types of agriculture are standing clearly outlined before us. Let us study the effects of each on the sections involved. First we note that the western type is primarily due to two factors, one of them being the genius of its mechanism, which is unsurpassed in any part of this broad world in the skill of its structure and application. Without it the west of to-day would have been an impossibility. There manual labor is at a minimum, machinery at its maximum use. In this lies the secret of its civilization and culture, which in this respect surpasses the credit given it by New Englanders. The other equally essential factor, without which its machinery could not have reached its great development, is its rich limestone soil, ground finer in the mills of the gods than our own granite soils, and more richly infiltered with organic fatness, accumulated during long ages past.

Cheap transportation and mechanism have enabled the rapid extraction of this fertility, and its sale upon far distant markets on terms that enabled the west to organize its evidences of civilization and to rapidly enhance the value of its lands. These forces, however, have expedited the neatness and completeness of soil robbery and the rapid withdrawal of the stored-up wealth of ages. The bounty of all time has been centred in the enrichment of a single generation.

Let us look for a moment at the relation of this excessive tillage on the fortunes of the west of to-day and of to-morrow. Dr. Sturtevant showed while at the Geneva station that his lysimeter under grass leached from the soil but 80,760 pounds of water, containing .3 pounds of nitrogen; while that tilled permitted 2,483,080 pounds of water to pass through it, and 218.2 pounds of nitrogen per acre. From a tilled surface less water is evaporated than from an untilled, and more passes off from the sub areas of the soil, carrying with it fertility. From these surfaces more material is washed and blown away while exposed to the atmosphere, and continually rolled by tillage into the freer embrace of the decomposing agencies of the air increasing decomposition of organic matter, either faster than the plants can make use of it or with the result that free nitrogen is formed. Leaching, occurring most in the spring and fall, when least covered with crops, carries plant food beyond the roots and largely into the streams. The Mississippi River thus gathers up and discharges 8,000,000 cubic feet of soil materials per hour, enough to lower the immense basin of the Mississippi valley one foot in ten thousand years. This of course represents the best part of the soil.

Harry Snyder found, as chemist of the Minnesota Experiment Station, the following deeply impressive facts, which I select from more abundant material of like tenor. Virgin soil in Warren county, Minnesota, contained .38 of one per cent of nitrogen, while an adjoining lot tilled for only ten years contained but .25 of one per cent. Crookston County contained .40 of one per cent of nitrogen, while adjoining ground tilled for nineteen years contained but .21 of one per cent of nitrogen. Land tilled for thirty years contained but .16 of one per cent of this element. Was this material carried away in crops? Twenty-five bushels of wheat per acre with its straw would for twenty years remove but from 800 to 900 pounds of nitrogen; indeed, less than this, for the straw is not all removed from the ground under the western system of wheat growing. Averaging the lots of the first two sets of figures given, we find that .165 of nitrogen has been lost from the soil. This, for an acre weighing 3,500,000 pounds, represents an abstraction of 5,775 pounds of nitrogen. Machinery and constant tillage splendidly expedite soil thieving, and perform in a generation that which the fathers would have required an age to have accomplished. They have mown into the ranks of fertility of western soils as the modern Gatling gun into the ranks of men. While the greater part of this loss of fertility is not due to that carried off in crops sold, yet the loss in this direction is a noteworthy one. The Indiana Experiment Station has estimated the phosphoric acid, potash and nitrogen abstracted in the annual crops grown in Indiana, at the market rates for these materials, at $104,603,700. The combined effects of fertility removed by crops and by the results of tillage have been to send crops down the scale of yield with a rush.

Some years ago I had occasion to estimate for my classes at the Agricultural College of Missouri the decreasing yields of the corn and wheat crops, and found, beginning with 1864, that in successive periods of five years each the corn crop stood as follows: for the first period, 30.8 bushels; for the second period, 32.1 bushels; for the third period, 27.1 bushels; for the fourth period, 26.6 bushels per acre. Since then the crop has remained practically stationary. The United States government, however, shows that for the country from 1869 to 1879 the yield of corn was 24.7 bushels, and from 1879 to 1889 24.1 bushels. As six of the Mississippi valley States raise more than one-half of the corn of the country, while the entire corn States of the west raise more than three-fourths of the corn of the country, it is evident that the decline of crops has not reached its climax. In sixteen years the crops of Kansas went from 17.2 bushels of wheat per acre down to 13.1 bushels, and is now still lower than that. Other States show the same general decline. The loss of 401 bushels of wheat per hundred acres, to say nothing of the decline in price, cuts most vitally into the luxuries and comfort that may annually be brought into the homes of Kansas farmers. Such farming is farming towards poverty and despair, and away from civilization and culture. The reader will understand, of course, that the illustrations given represent the tendency of western agriculture, and are only a few taken from the multitude of facts in my possession to represent a law involved in the effects of western extensive tillage.

The country as a whole, including the south, averaged but 24.1 bushels of corn and 12.1 bushels of wheat per acre, while the great wheat and corn producing States of the west averaged but slightly more than this, or say 28 bushels of corn per acre and 13 bushels of wheat, Illinois producing but 26.3 bushels of corn per acre and Iowa but 10.3 bushels of wheat, as the average from 1880 to 1890.

As wheat in the hands of producers to-day brings not over 40 cents per bushel, or at 13 bushels per acre $5.20, and corn 25 cents per bushel, or $7 per acre, no extended calculation of cost is required to show that the direct sale of tillage crops can return but the scantiest wages to the producer. Whatever of profit there is in western agriculture comes from the secondary products of crops, — beef, butter, pork and mutton.

Whether there is a profit in the animal products of the west is a debatable question, which requires a great deal of calculation, into which variable elements enter. The public are familiar with the fact that the sheep industry is on the decline in the west; that under the low prices that prevailed two or three years ago the number of hogs so rapidly declined as to produce a dearth of pork products; and that in the older western States the number of cattle fed is either stationary or on the decrease; thus, since the low price of 1890, oxen and other cattle have heavily declined in such States as Michigan, Ohio, Indiana, Illinois and Wisconsin. They have slightly increased in four corn States, — Missouri, Iowa, Nebraska and Kansas; although, since hope that higher prices for beef were soon to prevail began to fade in 1892, the number of beef animals has actually decreased in corn States like Missouri and Nebraska, while in Kansas the numbers have been stationary, alone increasing in the single corn State of Iowa from 2,707,049 to 2,731,385, — a practically stationary number. From this it appears that the western States prefer to sell their corn, oats, barley and wheat to making meat products at present rates. This seems to put the profit of meat making on a parity with that of crop production. Indeed, the papers of the west have stated during the present year that ground is being ploughed up from pasturage for grain production, as meat making is thought to be less profitable.

A little ciphering will show that there is no profit in the production of meat products in the west on the basis on which they are there fed. Accustomed to rob the soil as a source of his wealth, the western farmer expects, when he feeds out a crop, to get full pay for his time, without estimating the manure as a part of the income; while many feeders demand a profit for the operation, otherwise they prefer to sell the crops direct. Thus, where they rate land as it is rated at fifty to one hundred dollars per acre, it is quickly seen that three pasturings, or the cost of interest on two acres each season at the prevailing rate of eight per cent interest, and feeding of hay and grain for three winters, with the interest, risk and cost of labor on the same, narrows the margin of profit, especially under the system that prevails in the beef-making districts, where the entire year of service of a cow is necessary for the production of a calf. Interest, risk, care and depreciation of the cow will cost not less than twenty to twenty-five dollars per year in the settled west. Interest on pastures will amount to no less than eighteen dollars at six per cent interest.

Three and one-half tons of hay at six dollars and one and one-half tons of grain at ten dollars will add thirty-six dollars for cost of feed. Then there is the interest, salt, attendance and risk to be added, which makes the total cost for a fifteen-hundred-pound steer upwards of eighty dollars. At the best this reduces the prices of beef making in the Mississippi valley to the level of interest on capital and the lowest rates on day labor. This the average western farmer does not get in beef making to-day.

I have already spoken highly of the mental equipment of the western farmer and of his physical energy, and am called upon to explain his present unfavorable financial condition. Just as we have become settled in old practices to the detriment of our interests, has he become largely fixed in expecting his income from the natural fertility of the soil. Its response is now below the necessities of our civilization. It is a slow process for a great people fixed in a method to reverse that method. The west will be hampered even in the purpose of recuperative farming by the fact that the receipts of the farm have largely been expended in meeting the expenses of buildings, appliances and the debts of original purchase.

Many farmers of the west have accumulated capital and are using it in village life, giving rise to the class of men known as renters. This class of men has increased in the last decade or two, and constitutes the heaviest incubus upon the heels of progressive farming in the west and the hope of a sudden and high type of recuperative farming. Thus in Indiana twenty-nine per cent of the farmers are renters; in Illinois thirty-seven per cent hire their farms. This is an increasing ratio. These men do not rent on the long tenure of the English system, and have but a temporary interest in the farm. This is not the class who will lay the foundation of renewed fertility. It is not the class who will feed cattle for the purpose of the manure, and is the class that will feed them only when there is a direct profit in the transaction. This is the class that sell the crops from the farm.

I deeply regret to see the pledge of national security and the perpetuity of republican institutions, founded in the homestead act, which made the tiller of the soil its owner, and thus every tiller of the soil a pledge of peace and security, impaired to any degree by a class whose interests are less deeply rooted in the soil and the perpetuity of our institutions. While New England in this movement will have to meet a less vital competitor, I regret to see an equality of condition that arises from the distribution of land among the masses in any degree giving place to inequality and the envy and unrest that follows when poverty daily looks with envy upon the face of wealth.

I have run thus rapidly over some of the primary conditions that exist in the west, because the great subject that I am attempting to handle will not permit of detailing. I therefore turn from this phase of my subject to the New England farmer and his methods, contrasted with the western farmer.

We have not found the misfortunes of the west, as some have supposed, in an enervating climate nor in the lack of a virile race of men and women. Its embarrassments are found in a sparse population, necessitating the sale of its products in distant markets, and in the partial necessity of making those sales in the form of raw products, thus giving rise to an exhaustive type of farming. Compared with the west, New England has far poorer soils, higher railway rates per mile, has not the advantage that selling great masses of products gives, uses far less machinery, has poorer pastures, less skilled and aggressive breeders, less boldness of policy, and is, as we believe, more fixed in its practices. We have in the east the advantage of near-by markets, therefore higher prices; can produce better products, gain for them personal markets, have cheaper money, cheaper lands, better roads, more of permanent improvements, less expensive habits, purer water, and conditions that admit and compel closer industry, economy, and a keener exercise of intellectual powers. Not all of these have been applied in New England.

The west absorbed our most adventuresome and ambitious sons. The founding at home of new industries that modern science has developed demanded more of these sons, while both interests absorbed in inviting rates of interest the surplus capital that has been accumulated and was being accumulated by New England farmers. The older generation with their practices were left to maintain what has remained of the vitality of New England farming. The immense demand made upon New England farms has paralyzed its energies, while the vim of the great west, built up by New England blood and New England capital, poured in upon us by cheap transportation its rivers of products upon the less ambitious home stayers, who, to meet the new order of things, instead of breasting the tide, narrowed and narrowed the farm operations, until relatively less capital and less labor were employed upon them than in old times. If this policy was right once, we believe something braver is desired now. To till only eleven per cent of our arable land exclusive of pasture does not do credit to our stalwart ancestry, who bravely cleared our fields, erected our homes, established our improvements and the ideal rural New England of the poet and the statesman, and transmitted to the sons capital to continue them. Like France and England, we should till not less than one-half the land capable of it.

I should be pleased to enter into the philosophy of a tillage rotation, but time will not permit. It is well-nigh true to say that there can be no high agriculture without a high order of crop rotations, involving a large amount of tillage. I need not offer the demonstration that tillage aids in soil decomposition, — we have seen it in the west; but ours should stop short of continuous tillage, rather being that system that alternates tillage and covered crops, the one to aid decomposition and the other to absorb its products that might be wasted by continuous tillage as in the west. This would require an immense increase of capital, labor, machinery, manures and skill. Can we afford these and other necessary factors? Yes, if we are to measure steel with our western brothers, who have outrun us in aggressive progressive measures where they have seen the opportunity to apply them.

First, we have the cheapest lands in America, saving the dark belt of the south. The increase of renters in the west is due to the absence in the market either of free or low-priced desirable lands. Very few areas in the country are holding land at less than fifty dollars per acre, where a man cares to live. Incidentally I may say that New England to-day offers the best opportunity of the continent for a poor man to procure a farm home. Our cheap capital, now netting but three per cent in New Hampshire, and I presume the same in Massachusetts, leaves but a little net income on the purchase price of land at fifteen to twenty-five dollars per acre, as it can be purchased for over one-half of New England, to pay the interest, — not more than fifty to ninety dollars being thus absorbed by a one hundred and fifty acre farm. Here to-day is the most promising opening for capital, for little has to be realized to make the investment a paying one. The west cannot be met with any hope of success without using the tools that have served them so well. Muscle is foolishly governed that knows no better than to contend with machinery, and deserves any fate that may happen to it, speaking economically.

I am told that we cannot use machinery on the farms of New England. If this is so, let us throw them away, and be done with the vain struggle. The assumption is a false and fatal one to him who is governed by it. Ten dollars will equip a man with a simple arrangement to remove obstructive bowlders at a nominal price per acre, and help remove the bushes that are a shame upon the pretence to intelligent industry of every New England farmer who grows them. My neighbors in Missouri claimed that forty acres was a fair allowance of corn for a man to care for in a year. At a moderate sum, entirely within the bounds of economy, the average New England farm may be fitted for the use of every essential machine used on the prairies of the west, so that if a western farmer can handle forty acres of corn the eastern farmer can. Want of time will not permit me to dwell upon modern machinery. It is as tempting as it is an important field. Something more is involved than the mere question of economy. Man, morally and mentally, in all his possibilities of culture, is in this balance. Any economy of muscular energy reacts upon him. When all the energies of man are exhausted in muscular labor, none is left over for mental growth; and wherever muscular energy becomes the sole motive force, man is lowest in the scale of civilization among the workers of the world. The habit of excessive muscular labor has been found incompatible with the activities of the mind. The New England farmer will not be man enough to balance his western brother until muscular tension is relieved by the substitution of other forces to operate abundant mechanism on the farm. Machinery is a *sine qua non* in the mental and material growth of agriculture. No can't comes in here to veto the free use of machinery. The failure to use it is the final failure of New England agriculture; and the quicker any man who cannot accept this saying gets out of farming, the better for him and his country. I am practising what I am preaching, and either the rocks on Wilson farm that obstruct machinery are going, or I am; and, as I do not care to move, the rocks are moving into unobtrusive places, and machinery is asserting its supremacy and girding itself up for a trial of strength with its kindred in the west.

I shall be told that labor cannot be secured for carrying on broad operations on the farm. I was told so before commencing operations on my own farm, and if I could employ it, it would be Ishmaelite in character. I suppose these claims represent in some respect the belief that we have taught ourselves as an apology for our passiveness in farming. Now, at the expiration of several months of uncertain workers on the farm, I have six regular men; and I doubt not, if we are honest with ourselves and honest with history, that we shall acknowledge these men to be the match of the wonderfully good laborers in sentiment that the old hands employed in the good old times. It is a simple proposition with us: a comfortable home for man and wife, fair pay and reasonable hours of labor, and work for three hundred and thirteen days of the year.

But it is said that we cannot carry on extensive farming as in the west, because we have not its fertility of soil. Is this statement true? Really have we not an advantage over them in some regards? Can we not carry on not only extensive farming but extensive intensive farming, thereby exhibiting the true genius of man in agriculture? To make it extensive, it is true we must clear the fields of rocks and make use of all the available pasture ground; and to make it intensive we must fat it all, including that portion which we cannot plough, by feeding it until it becomes the match of western pastures. With more labor, more and cheaper capital than the west commands, there is no trouble at all in fitting the fields for machinery; no trouble about the profit of it, provided we can furnish the fertility. Here is the rub; and here is the pivotal spot where we must look in detail and with some care.

Let us take the corn crop as an illustration. Can we grow the forty acres of corn that our western contemporary can, so far as furnishing the plant food is involved in the scheme? Let us look. Fifty bushels of corn and its fodder contain in round numbers thirty-one pounds of phosphoric acid, sixty-four pounds of nitrogen and some seventy pounds of potash. As it is quite satisfactorily shown that only one-half of the nitrogen needs to be supplied, the cost of these materials, rating nitrogen at fifteen cents, potash at four and one-half cents and phosphoric acid at seven cents per pound, will be $1.06, or twenty cents a bushel. While not all the chemicals applied are returned in the first crop, they are so nearly returned plus the natural production of soil that in a series of years, at a fair compensation for increased fertility of soil, the figures may stand as representing the cost in fertility for a bushel of corn.

What will it cost to ship a bushel of corn from the west here? — The tax that the western farmer pays to railroads for the opportunity to sell in our markets. From Chicago to Boston for July, or for the cheapest rates for the year, twenty-two cents per hundred pounds is paid for corn. From Kansas City or Omaha or from western points where corn shipments are now the heaviest to Chicago, another twenty cents per hundred pounds, making a cost per bushel of twenty-three and one-half cents, or three and one-half cents more than the cost of chemicals for a bushel of corn. When we purchase chemicals our farms are growing richer and the western farms are growing poorer, — growing easier for us and harder for them.

As some may make the criticism that Kansas City is a point too far west from which to calculate freight rates, I may reply that the rates given are over great trunk lines for large quantities. The great bulk of shippers of corn live on lateral and local lines and sometimes on sub-lateral lines, and behind these lines is for the great bulk of shippers the cost of delivery by teams. The same calculations will be found true for other crop products of the farm.

In a less measure they are found true for meat products; and yet I contend that meat products are likely to become more prominent in New England than they have been, for the reason that prices will probably be better in the future, and because we are about to learn that we can produce crops by the use of machinery, chemical and yard manures combined, cheaper than we have been aware of. It is our function to-day to generalize more than to specialize, yet an illustration will serve to redeem our suggestion from unmeasured contempt by those who have long abandoned the hope that New England will again raise meat crops.

The sulky plough will turn an acre of ground for $1.25; the sulky harrow will fit it for sixty cents; a two-rowed corn planter will plant it for twenty-five cents. Ten dollars will furnish the chemicals for four tons of air-dried fodder corn. Sulky cultivators will repress the weeds for another dollar. One dollar an acre will cut it up, and one and one-half to three dollars will house it, according to where it goes, — into the mow or silo. As the husker and the grinder will keep hands off of this crop, the total cost will be $17.10 per acre. The western farmer will not grow it materially cheaper. The average farmer of the west no cheaper. If this is true, he can make beef but little if any cheaper, probably no cheaper when delivered in our markets.

Let us take another look at this corn question. The Illinois farmer grows twenty-six and one-tenth bushels (I do not understand this average farmer nor the statistics relating to him, for those whom I know grow more than this per acre) ; if we grow fifty bushels by the use of chemicals, we obtain twenty-three and nine-tenths bushels larger crop per acre for the expenditure of ten dollars for chemicals. Now, this excess crop costs but little more per bushel than the twenty-six bushels grown without chemicals by the Illinois farmer, as all the cost of tillage is to be paid by him for the small crop.

Another factor comes to our assistance, and that is the superior value of the fodder in New England. Indeed, on most western farms the fodder is substantially thrown away, being fed off of the ground by cattle after the corn has been snapped. By this system ten acres is estimated to feed a steer for the winter, while one acre would furnish the food in New England by our system. Some of my hearers no doubt have learned that the western farmer is beginning to use chemicals. Armed with our weapons, will they not meet us on equal terms in the manuring of crops? Chemicals are the insidious foe of the farmers bordering either side of the Mississippi and the Missouri rivers.

Years ago I estimated for Missouri students the cost of chemicals to raise forty acres of corn of fifty bushels per acre, forty acres of wheat of twenty-five bushels per acre and twenty acres of hay of two tons to the acre, this being something like the distribution of crops that the tillage farmer of the west makes. Wheat at seventy-six cents per bushel, corn at twenty-five cents per bushel, hay at six dollars per ton, will give a return for all these crops for one hundred acres of $1,490; the chemicals to raise these crops then would have cost $1,264.80, leaving a net credit of but little over $200. Crops were then rated at more than they will now bring, the wheat by $250, the others about the same now as then, while the chemicals were rated slightly above present market rates. In short, the crops of a renter's farm in Missouri to-day will not sell for more than enough to purchase chemicals to grow them, except as it can be achieved by feeding live stock. Intensive extensive farming is not now possible in the west except as a slow growth and at the expense of saving liquid and solid manure and the application of the same, which means an era of increased cost in its methods of agriculture. This seems to be, when coupled with rotations, the true direction in which the western farmer should move. We have already seen that a strong movement is setting in this direction, also more of their cows heretofore kept solely for calves are being milked for butter production. More of their manure formerly wasted is being applied, and their corn fodder in part is being more carefully conserved. Between the farms thus reducing their waste and those held by renters and poor farms operated by old methods, I presume that the time has arrived or is about arriving, when over the old west, or the west east of Kansas and Nebraska, farmers are maintaining the present level of crops, and may be preparing to slowly ascend the scale of crop returns which they have descended.

Statistics show that New England began this movement in advance of the west, and we know that market rates make it possible for us to go into extensive intensive farming to greater advantage, cheap farms and cheap capital, as before intimated, being favoring conditions.

In estimating the relative capacity of the east and the west to produce crops cheaply in the future, it is not to be forgotten that our roads are superior to those of the west, and, except hills that might be circumvented and a short period of mud time in the spring, hard to beat for pleasure or for business without far too great an expense, for nature has made the earth of our granite soils well fitted for substantial road beds. On these farms are houses, barns and substantial fences that of themselves cost double the present purchase price of the farms, and requiring less annual outlay and future cost of improvements than western farms.

The value of our diversified markets, where individual sales are made at special rates for extra fine butter, fresh eggs, poultry, fruits and a line of the more refined products of agriculture, is great. We do not suffer from the dispiriting influence of distant markets, and are aided by the reflex action of diversified industries on the ambition and *morale* of farming. Farming is not likely to have in it, when isolated from other industries, quite that snap that it would have when exhilarated by an example of successes and culture of high order on every hand. It must be confessed that this principle seems to have little application in this section, for the agriculture of the west has been more spirited than that of the east. This I have explained in the fact that a race of men of moderate means have sought in the west homes and fortunes upon soils where nature has done much for them, and which they were bound to take advantage of in building up the essentials of life around them, New England being dispirited by abnormal profits and opportunities afforded in the west and in eastern cities, both for its young men and its money.

That era and all that characterized it are dead forever. Overaction has settled the fertile lands of the country, until in remote areas they are higher priced than near our great markets. Capital has hunted for and operated the visible opportunities for sudden wealth that a new continent affords and that new discoveries in science opened up to us in profuse array. And now the reaction is apparently setting in, fortunately before rural New England has passed the point where it fails to retain enough of recuperative strength in men and money. Men and capital are beginning to see that our old farms afford a reasonable opportunity for each, and I predict that New England agriculture is about to enter upon the most glorious era of its history. The cry of abandoned farms is no longer to advertise the apparent paralysis of New England farming.

The last census has shown that rural New England calls no louder for sympathy than the rural south and the rural west. We notice that in such States as Alabama and Virginia in the south, Kansas, Missouri and Illinois in the west, and California on the Pacific slope, — in fact, all sections of the country exhibit rural counties whose population has declined.

The dazzle of the city has been as glittering and magnetic to the boy of the west, of the south and of the Pacific slope as to the boy of the middle States and New England. Counties like Andrew and other counties that I am familiar with in north Missouri, unsurpassed in agricultural capacities by any section of America, show a falling off in population.

In the inter-mountain region, where at the touch of the waters of irrigation a luxuriance of crops springs to life unknown to the Mississippi valley, far-off Utah, a thousand miles from other civilizations and their markets, has its counties which have reached their flood tide of population and are ebbing. Two miles from the town of Logan in this scorned territory land is higher than it probably is within two miles of this old mart of international commerce and of local trade in which this Board is now in session. Even in Kansas and Nebraska, hardly yet in their childhood, speculation has reached its opportunities and turned its back upon many counties of these lands of milk and honey.

A boy in Illinois who desires a farm must pay one hundred dollars an acre for a good quarter-section, or sixteen thousand dollars; and not less than twenty thousand dollars will man for action one of these quarter-sections. Farms in central Iowa command fifty dollars an acre, and if any sell for less it is because public judgment holds them of inferior value, so that not less than twelve thousand dollars would be required to capitalize them. Where more than one son is born on a farm in Iowa, it has to be divided, or the landless son faces a harder road to land ownership than his cousin in New England.

Clearly the time is coming in the history of New England agriculture when courage should be joined to capital and machinery in fitting its old farms to enter bravely into the arena of competition with the rest of the world. To these New England farms, in the belief of the speaker, should be applied more tillage, for the following reasons: because, in working capitalized lands, the farmer is made more of a capitalist and less of a laborer; employing more labor makes the farmer more of an executive or business man; in tilling more in this northern latitude in our brief seasons it levies more on the decomposing influences of atmospheric agencies, because it necessitates regular rotations, which of themselves unaided tend to increase crops; because it involves more of purchased chemicals and greater possibilities when these are used in conjunction with yard manure; because it includes more of purchased foods valuable as manure makers and valuable as accompanying foods with the straw products of grain and corn grown in each rotation; because it distributes labor more equitably over the seasons, and when wisely organized requires it for the year and develops better laborers; because it multiplies the revenues of the farm several fold, and creates a possibility of profit where none exists under the present system; because it requires more brains in farming, and makes of the farmer a more cultivated man, elevating his social position and dignity; because in requiring all these it makes the industry the most varied, the most intellectual and the most fascinating known to man.

There is no longer cause for the New England farmer or farmer's son to seek new lands to conquer, in a distant, sparsely populated section of the country, where industry runs in few grooves and life is less varied.

The CHAIRMAN. You have listened to this very interesting and very candid statement delivered by the professor, comparing the agriculture of the west with the east. He has had large experience, and has given it to us in a way that we can understand. I have no doubt there are many in the audience who have questions to ask or experiences to relate, and remarks or questions are now in order.

Mr. F. A. BLISS. Mr. Chairman, the gentleman has advocated the use of machinery. I would like to ask if there is machinery that would be practicable for the farmer to purchase and use for removing the rocks and bushes from our New England farms?

Professor SANBORN. Yes. I have removed several hundred bowlders from my own farm, and many hundred trees.

The implement I used is a very simple affair. It consists of a very strong beam and handles much like a plough, with two curved steel prongs fastened on each side of the beam and running down in place of the iron part of the plough. These prongs are forced down in the ground behind and under the bowlder. I hitch the beam to a pair of wheels with a yoke of oxen, and I easily pull out rocks that weigh a ton to a ton and a half. I bought a farm of one hundred acres adjoining mine, which was full of bowlders everywhere, and I pulled out as many as thirty or forty in an hour. I put those bowlders on what we call a stone boat, and took them to the wall, although many of them were used in ditches for draining the land. Some of the fields of my neighbors are broken up by little runs into little patches. We dig drains in all this land and fill them up with rocks, and run our plough right through. We cannot afford to go around rocks and runs; we started in for business.

Mr. L. W. WEST. I would like to know whether that machine will pull a white birch stump six inches in diameter?

Professor SANBORN. Yes. Most of the trees that I am pulling are standing, though it will pull stumps. It gives an upward lift. You hitch it onto your axle-tree, and when you pull, it does not pull right against the face of the earth, but this incline of the lift takes it out of the ground very easily. My father, who was always inventing machinery, took a common ox-tongue and made one for himself.

QUESTION. Would you use the same instrument in removing bushes from land?

Professor SANBORN. For sage growth and the general run of bushes I back the wheels right up against the bushes and hitch up as tightly as I can, and pull the bushes very quickly.

Mr. LITTLE. I would like to inquire what method the speaker would advise where the bushes are too small to hitch a team to them, for instance, elder, barberry or huckleberry bushes.

Professor SANBORN. Probably you can advise as to that better than I can, but we use a heavy plough and root them out.

Mr. LITTLE. I find that simply mowing them off once or twice a year won't kill them.

Professor Sanborn. You want to dig them out. When I was a boy I used to mow them, and recently I saw the same bushes that farmers have mowed annually for twenty years; every rock in the field is familiar, and they are ploughing right around them, as they were twenty years ago; and I said, "What a spirit these men have! Talk about farming! Why, those men do not know anything about farming." Think of a man mowing around rocks and bushes year after year. It is not farming; it is not a fair, honest pretence of farming. There is nothing brave or bold or manly about such farming. It puts you to shame when you think of it.

Secretary Sessions. I want to say just one word in relation to this question of Mr. Little's. Riding on the cars a short time ago I met a gentleman from the town of Princeton in this State, and another seat-mate said to me, "You ought to hear what he can tell you about getting rid of brush in pastures," and of course I was interested, because I have mowed brush, too. He said an application of salt that would cover the ground and make it white around these bushes would kill them completely out, and that he could get a refuse salt for a very low price. It would kill the grass, but by sowing grass seed the following season the pasture was much improved.

Mr. French (of North Hampton, N. H.). I am an old farmer; I have been a farmer all my days. I am seventy-six years old. My father was a minister of the gospel, and he tried to make one of me, but I chose to be a farmer, because I love farming. I love to see things grow and help them grow. I love to work, and never believed that work was a curse to any man. The great curse is laziness and shiftlessness. I admire the remarks of our lecturer to-day, and I can fully coincide with them in almost every respect. I believe, as he does, that the only way to remove rocks and stumps is to be thorough with them and tear out all the bushes by the roots, instead of using salt or anything of the kind. I have completely cleared up at least three-fourths of all my pasture land, cleared it entirely from rocks, bushes, stumps and everything of the kind, and put it all into good mowing. I married a farm with my wife, and the next morning after I was married the man who was on the place said to me, "You have got here one horse, one yoke of cattle, a few sheep, four cows and a heifer, and you had better sell the heifer, for four cows are all that you can summer on this place and all you can winter, and all that you ought ever to think of keeping." I made no reply to him, but I thought if I lived I might improve somewhat on that. I am now on the same place, with a very little addition, and I can keep and do keep ten horses, and can keep fifty cows and fifty hogs. I keep those cows and that stock a great deal better than those four were kept, and it has all been done simply by hard work and improvements. I have laid some three miles of drain tile on my place, and simply by industry and improvements I have certainly made five spears of grass grow where one grew before. I wanted to ask our essayist if he thought it necessary for successful farming to use chemicals for manure to any great extent, for I think I am farming pretty successfully, and I use but very little.

Professor Sanborn. Well, it is for me, and I will try and state my reasons. Our soils are far below what ought to be their productive capacity, and I do not want to devote a lifetime to developing their fertility, as this gentleman has done with his. I want to bring the soil up in a short time. Chemicals are of great value in carrying on a farm, and you may use them as extensively as you please. I am working on a four hundred-acre farm. I keep about one hundred and sixty acres ploughed each year; on those I propose to put chemicals liberally, and in the space of ten years I hope to get the farm in good condition. I cannot afford not to use them, because they pay me as I go. We have been using them on the farm up there, and we know that they are a successful and profitable plant food. Real farming does not consist in playing round a few acres each year. That is not a bold policy for men who live on these hills. It is not a question of what we can get along with, but how much we can accomplish.

Mr. A. Pratt (of North Middleborough). I would like to ask Professor Sanborn as to the estimate that was made of chemicals in his essay. Was that applied with farm-yard manure, or without it? If without farm-yard manure, what proportion of chemicals would you use for a good crop of corn?

Professor SANBORN. Well, I shall apply them to thirty or forty acres of corn next year without any manure, but I have not made up the list. I shall apply about half the nitrogen that the crop is supposed to take from the soil. I shall apply probably about two hundred pounds of nitrate of soda to the acre, of dissolved bone-black probably about seven hundred to eight hundred pounds, and of muriate of potash probably about three hundred pounds to the acre. That would be all the materials that seven or eight tons of dry corn and fodder get to the acre. I am expecting to get back in the crop about fifty per cent of what I apply the first year.

Mr. PRATT. Do I understand that is for fodder, or a crop of corn?

Professor SANBORN. I do not have any husking. It all goes into the silo. I do no grinding. There is a gain by this method. The husking does not add one dollar to its value. You spend twenty-five per cent of the value of the crop in manipulation, and you have nothing left.

Mr. PRATT. At what stage of its growth do you harvest that crop?

Professor SANBORN. As near maturity as possible. It is my contention that a crop grows up to maturity, and I take no crop off short of that time.

Secretary SESSIONS. Do you aim for a crop of ears?

Professor SANBORN. We aim for a crop of ears.

Mr. BLISS. I want to say a word in regard to removing bushes and stones from our land. As a matter of fact, we know that the most valuable land we have on our farms is the low land, but this low land is the land that is left to grow up to bushes and trees. It has been my effort in the last few years to bring under cultivation this low land. I have laid from one thousand to fifteen hundred feet of drain tile a year in this low land, and I find that it is the most profitable work that I do on the place. Some of my neighbors have used refuse substance from the gas works, something like lime, for killing trees. It is effectual in killing trees and bushes, and it does not injure the soil after one or two years.

Mr. CLARK. I think the professor was going on to state what means he had used for eradicating these small bushes. I would like to know about that.

Professor SANBORN. I said where they were too small to pull I simply cut them off, ploughed them out, and that settled the question.

Mr. FRENCH. I have increased the fertility of my farm simply by keeping stock, and I find that the more stock I keep the more I can keep from year to year. That is how I have increased my stock from four cows up to fifty.

Professor SANBORN. One gentleman asks if I put my corn into the mow. I should, some of it. I should feed it out whole to the cattle. It is known now that corn ground is not much, if any, more effective than unground. Wherever you allow pigs to follow the cattle, the sum total you get when fed whole will be greater than when you grind it; therefore where I feed corn I have hogs follow the cows, and we lose nothing in that way.

Mr. PRATT. How do you cure it before putting it in the mow?

Professor SANBORN. In the usual way, then pack it in the mow solid, not put it in loose.

Professor WHITCHER. Do you ever get heat enough so the corn sprouts in the mow?

Professor SANBORN. No, I do not. My experience in New Hampshire in storing in that way is very limited indeed. I have stored it in the West in that way successfully.

Mr. PRATT. After removing the corn, what is your method of putting the land into a grass crop? With commercial fertilizers, or farm-yard manure?

Professor SANBORN. I contemplate the following rotation: forty acres of corn, forty of potatoes, forty of barley and forty of timothy. I am uncertain about the grain crops, whether the time has gone by for the growing of them, and my rotation is tentative.

Mr. ——. Have you given any of this whole corn to your horses?

Professor SANBORN. I have not yet. There is no objection to it. The system of feeding corn by the Western men I like quite well. They have mills that crack it and grind it coarsely. I have always been accustomed to grind it finely, but subsequent observation has convinced me that corn that is ground coarsely is better than very finely ground corn.

Mr. BLISS. I do not quite understand what the professor says about grinding. When he runs across our own ideas, we want to understand it thoroughly. In our section our farmers are after the millers constantly to have them grind finely. Now, is it a fact that the meal is better for dairy purposes to be ground coarsely?

Professor SANBORN. Perhaps I may have been misunderstood. In regard to grinding coarsely or finely I draw my conclusions from the experiments carried on at the stations. I have fed both kinds, and sometimes ground corn gave more increase than unground, but nearly all the time the whole corn gave as good results as the ground. The corn that passes whole is picked up by the pigs, and almost invariably I have obtained more from one hundred pounds of whole corn including the gain of the pigs than from one hundred pounds of ground corn. Now, as to whether it should be ground coarse or fine, I am convinced that corn coarse ground is better for this reason. If you feed bountifully and have swine follow the cattle, nothing is wasted.

Mr. PRATT. Do you find that cattle eat the fodder up as well when the ears are upon the stalk? Are they not inclined to pick off the ear and reject the fodder?

Professor SANBORN. We find that they eat it all up. There is no doubt that they eat good dry fodder as well as they eat ensilage. With strippers I used this dry fodder at the New Hampshire college farm. There I used to get every pound of it eaten.

Mr. F. A. PALMER (of Stockbridge). Have you ever used sweet corn fodder for your stock?

Professor SANBORN. I have used it in the silo; that is all.

Mr. PALMER. What do you think of it for feed?

Professor SANBORN. The particular lot I fed did a little better than the other fodder.

Mr. PALMER. We farmers come here from all over the

Commonwealth, and want to carry back a little information that is practical. I believe in theory, but when theory and practice come together it is well, and that is very encouraging to us. When we farmers speak of our practice and find it corroborated by the experience of others, we feel better about it. I have had the same experience with the essayist, in that I could not afford to pay a miller to grind my corn, hence in raising that crop I have leaned in favor of sweet corn; and I have also leaned in the direction of putting the plough in and destroying the bushes, and turning these stones into drains. A year ago this fall I began work on a pasture bordering on a swamp, where there were a great many hardhacks. The hardhacks come up like white birches, while you sleep. I said I could not bear that condition of things any longer,—this wild grass and hardhack in my pasture. I got up a little courage and started in and ploughed up about fifteen acres. I broke up all the stone that I could, having a good stout man, with a sledge, and they were mostly laid in a drain. Without multiplying words, I may say, in confirmation of these gentlemen who have spoken about breaking up the land, that when I passed through the fields of my neighbors this summer I saw small crops withering under the sun, while on that low, heavy land that I drained were the heaviest crops of corn, potatoes and buckwheat that I ever saw in my life,—and we do sometimes have good crops out in old Berkshire. The president of the old Berkshire Agricultural Society said, "You have turned that old pasture, that was not worth one cent to you, into land worth one hundred dollars an acre." Those were his words. There is a stimulus, as the lecturer said yesterday, in this kind of work. Let us stimulate our boys to go into this work. Let us take them—I mean after we give them a good education at Amherst—and make these waste places blossom like the rose. Then we can keep our boys on these New England hills, and we can vie with our brothers in the West, and raise our own crops on the field, and our own crops of boys and girls worthy of these old pilgrim shores of eastern Massachusetts.

Mr. Coe (of Hingham). Mr. Chairman, I have done a little clearing up of land in the way of removing stones, trees and brush. The best thing I know of to remove brush is to have a good strong plough and a strong team, and plough up the bushes by the roots. In removing white birches, where they grow in clumps, take two sticks three by four, cross them and bolt them together near one end, and stand the frame about a foot or a foot and a half from the clump of white birches, throw a chain over the top and hitch it around the clump of birches, and one horse will generally pull them out easily.

Professor SANBORN. How do you make the hitch?

Mr. COE. Put the chain around just as you would around a log or stone.

Professor SANBORN. Throw it up over the top?

Mr. COE. Yes, sir. Just let the legs stand on the ground, and as you pull you get a lift just the same as you get a lift on your axle.

Professor SANBORN. Do those legs describe a circle?

Mr. COE. Those legs stand a little away from the birches, and your chain goes over so you can lift as you do over the axle. It is the same principle that you apply where you are removing very big trees.

Secretary SESSIONS. I want to say one word more in reference to the use of salt. There are, as many here know, hundreds of acres of rocky pasture lands in Massachusetts on steep side hills, that, unless something can be done to keep the bushes down aside from ploughing, will soon be of no value to our farms. I think those are the places where salt can be used to advantage, not where the land can be ploughed.

Mr. LEE. Why would it not be desirable to bury the rocks?

Professor SANBORN. It is more costly to bury them than it is to handle them. With this machinery you can clear the whole land for a very small sum of money, and I want to say that every acre of land that is adapted for machinery ought to be worth one hundred dollars, at the rate of interest we now have, for interest is only three or four per cent, and when your land is fitted for ploughing with machinery it is at once converted into a possession of value.

Mr. C. M. LUNT. I have been interested particularly in this matter of clearing the land in the old State of Massachusetts, especially in Berkshire, — perhaps more interested in that than in any point I have heard mentioned. But what I want to get at is this, whether you, professor, or any of the members of the Board, would, after raising up a family of daughters, throw them on the world with any of these Amherst young men you know of to get a living on any one of these rocky farms. I take, among other papers, the "New England Homestead," and lately there has been more or less said about the mortgage lifters on the farm. I find almost all of those men have borrowed one, two or three thousand dollars, and they have spent more on those farms than they are worth. I am a farmer myself, and I have wrested my living from the farm. I have no boys, but if I had I would not advise them to clear up this rocky land. It seems to me there is plenty of good land or better land than this rocky land that can be brought under cultivation, and especially near a city. I believe that a farmer, if he is interested in farming, can go into intensive farming and make more money than he can drawing rocks. Why, it staggers me, Mr. Chairman, to think what our forefathers did in this State. Just think of the stone walls they built. My labor costs me on an average $1.50 a day, and I cannot afford to lay rocks in a stone wall, for it tumbles down. I cannot afford to do it.

Professor SANBORN. The gentleman asks a question about marrying our daughters. I would like to ask the audience where you would prefer to trust the fortunes of any of your daughters, — as the wife of a man in the city, a paid agent of somebody to whom he is subservient, telling him to go here and there, with all the chances and mischances of life, or as the wife of a man who has a farm, with the knowledge and ability to carry it on successfully, and who is sufficiently cultivated to read the literature of the day? I do not think there is any great fortune in farming. Do not understand me that way. The time has gone by for wealth-getting in a short time on this continent. We have gone over our continent; we have found our mines, built our railroads and established our industries. The period of getting wealthy in a night — mushroom wealth — has passed away. We are to-day in the European condition, where we are simply moving along fixed lines of industry, acquiring simply a competence and little more. While in some of the industries here and there a man may amass wealth, yet taking into consideration the chances of life, would you not feel more secure with your daughter on a farm which her husband owns than in the city with the general outlook to-day?

Mr. Lunt. I must say that I am not in love with the farm and farming. I have not much more than the average interest in farming in comparison with my neighbors from the county of Essex, but I try to make farming a success. I have not heard a young man endorse the ideas of the professor yet. The endorsement all comes from these men with the golden crowns. I know that money can be made on the farm, but it seems to me doubtful whether one could do as well on this rocky land as he could on other land in the State of Massachusetts that is in the market at a low price.

Professor Sanborn. I think every gentleman in the audience will understand that my judgment is sufficiently mature to know better than to advise one to take land that is covered with bowlders. I am speaking of farms where, if a few dollars were put out in the way of clearing them up, it would greatly improve their condition, and where those few dollars would make the difference between modern farming and ancient farming. The best land will go into fields, and the poorer will go into forest. I do not advocate farming under conditions that do not permit the support of man or civilization. I have too much love for the yeomanry of a country to send them out to that sort of a living; but our farming must conform to the new order of things, and if the new order is not worth developing, the business is not worth undertaking.

Mr. Lunt. I will ask the professor if he would advise a young man to undertake farming without money? It seems to me it is a matter of business. If he goes into farming he has got to have capital, unless he carries a mortgage.

Mr. F. H. Plumb (of Westfield). It is the same in any business. I know of a farm in the "Catalogue of Abandoned Farms," of 370 acres, with two houses, four barns, 50 acres of mowing land and 50 acres of woodland, near to churches and a school-house; there is also an elegant fish pond a mile long within ten minutes' walk; and that farm has been sold for $700, and only $350 down. The other $350 can be paid up when you want to, and the taxes are only $13.50. Now, where is the business man that can show any such opportunity?

The CHAIRMAN. I have had the name of Mr. E. A. Emerson handed me. I would like to hear from him.

Mr. E. A. EMERSON (of Haverhill). I can say that I have enjoyed the address of the morning, and it is in the line of that address that the future prosperity of New England exists. I believe in progress. I believe in that kind of work, and if we are not willing to put the push and energy and intelligence into it which it demands, we had better get out of the business.

Mr. LEE. I had a brother eighteen years old. He was used to work on the farm. He was stout, strong, healthy, and had a great deal of energy. He had a call to go to Boston at the age of eighteen years. He went, and in twelve years he has earned about ten thousand dollars and got a good position; and I asked him, "How much have you saved of that ten thousand dollars in the city?" "About one-fifth." Now, the question arises, had he staid on a farm those years and worked with that energy, would he not have accumulated more? Would he not have more to-day? That is the question.

The CHAIRMAN. We shall be obliged to close now. I am sorry to cut off this discussion. We will adjourn until half-past one o'clock this afternoon.

AFTERNOON SESSION.

The meeting was called to order by Secretary SESSIONS, who called upon Mr. WHITAKER to state the result of his tests with the Babcock milk tester.

Mr. GEORGE M. WHITAKER. Time is so precious that there is none to expend in explaining the test at all, or to give you anything more than the results. I have tested one sample of cream which gave 18 1-2 per cent fat, — cream raised by the Cooley process, a good, fair, average sample of Cooley process cream. I have tested two samples of skimmed milk. One tested two-tenths of one per cent and the other five-tenths of one per cent, one sample having more than twice as much fat as the other. One sample of buttermilk was tested which had an extra amount of fat, two per cent, in it. That is absolutely a waste of nearly two pounds of butter in every hundred pounds of buttermilk. There were two samples of milk tested, one from Mr. Evans' herd, the other from a herd of milch cows here in the city. One tested four per cent and the other four and one-half per cent of fat. Mr. Evans brought in some specimens of milk representing the first half of the milking of one cow, and another sample representing the last half. The first tested two and eight-tenths per cent, while the second tested four and two-tenths per cent, showing quite a difference between the quality of the milk in the first half and the second half.

Secretary SESSIONS. I now turn the meeting over to Vice-president GRINNELL.

Vice-president GRINNELL then took the chair, and said: The lecture this afternoon is on a most interesting and important subject, by an accomplished man, — "Insecticides and fungicides, and their practical application," by Prof. S. T. Maynard, professor of horticulture at the Massachusetts Agricultural College. I think you will derive great benefit from this, and it will require attention. Our friend, Mr. GEORGE CRUICKSHANKS, well known to you as an eminent horticulturist, will preside at the meeting.

On taking the chair, Mr. CRUICKSHANKS said: There is no farmer who grows orchard fruits but must know from the press and from the bulletins of the Station what an immense amount of benefit is derived from spraying for insect pests and fungous diseases. After frequent visits to Amherst for the last few years I have become satisfied that the time is near at hand, if not here already, when, if we are to command a paying price for our orchard fruits, we must resort to spraying. I am glad that we have so able a representative as Professor Maynard to present that subject to this audience this afternoon. I am only sorry that these seats are not better filled by those who devote so much time and patience to planting trees and taking care of them. I now have the pleasure of introducing to the audience Professor MAYNARD of Amherst.

Prof. S. T. MAYNARD (of Amherst). Mr. Chairman and members of the Board of Agriculture: Before beginning the subject of the afternoon, I wish to make a few statements in regard to the evaporators which have been on exhibition below. The immense quantity of fruit which goes to waste, and especially of early varieties of apples, has led to a series of experiments at the Hatch Experiment Station in the use of evaporators for preserving this product. We have been using three evaporators, — the American evaporator, the Stahl evaporator and the Topping. These evaporators were run for nineteen days, and they were run in the first place to determine the work which each evaporator would do. The American evaporator used 30 bushels of apples. The product was 194 pounds, an average of 6 1-2 pounds to a bushel of fruit. This fruit was droppings and cullings from cider apples, and the product is shown in the samples below, although selected, and a little better perhaps than the average of the products. The cost per pound is about 5 cents. This varies a little with the different evaporators. The market price of the product we found according to the wholesale market quotations to be from 6 to 9 cents per pound. The retail market price quoted 13 to 14 cents per pound. At this season of the year the price is very low, but there is almost always an increase in price as the season advances. Taking the range at 6 to 9 cents at wholesale and 13 to 14 cents per pound at retail, we have a value in the evaporated apples of from 39 to 92 cents per bushel, without, of course any sorting, packing or barrelling. In the case of the Topping 44 bushels were used, producing 272 1-2 pounds, an average of 6 1-2 pounds of dried fruit per bushel, at a cost of a trifle over 5 cents; the Stahl consumed 50 bushels of apples, producing 323 1-2 pounds, producing 6 1-2 pounds per bushel. We find that there is a great variation in quantity, according to the condition of the apple, according to the kind of apple, also the size of the apple. The larger the apple, the less will be the loss. The riper the apple, the greater will be the loss.

These evaporators are advertised as having a capacity as follows: the American, from 8 to 10 bushels per day of fifteen hours; the Topping, from 8 to 10 bushels; the Stahl, from 8 to 12 bushels. The best we have been able to do is to produce from 4 to about 6 bushels in a day of ten hours, the difficulty being in the time which it takes to evaporate the fruit after it is pared. If the evaporator were larger, better results would be obtained, as the paring machine which we used would enable us to prepare and put into the evaporator many more bushels of fruit. That is of interest to those who are engaged in evaporating fruit. I have figures from one man who has an evaporator guaranteed to evaporate 50 to 60 bushels of fruit in a day of fifteen hours. The owner of this one has been running it more or less through the fall, and has been unable to evaporate more than from 20 to 25 bushels with two men and two boys, taking up their time completely, and thus producing about the same proportionate amount that we have been able to produce from these smaller evaporators. In the larger establishments, where the business is conducted on the co-operative plan or in some other way, evaporators are used having a capacity of from 50 to 200 or 300 bushels per day; and in almost any community where the fruit crop has been as large as it was the past season there would be no difficulty in keeping one of this capacity running from the first of September to the first of January, utilizing the different varieties as they mature; and the product, as we find, is very much better from fresh fruit. If we take the early apples, like the Porter, just as they are in condition for falling from the tree, while they are still firm, we can save everything; there need be no loss of anything except the cores and skins, and the apples which are too small and imperfect to produce any product at all. Different varieties give us a different quality of evaporated fruit.

We have in the room below samples of Baldwins evaporated by the different evaporators. There is also one sample of the apple known as the Swaar, a variety not very much grown, but it illustrates the difference between the Baldwin and that variety. You will find the varieties which give the best result, the whitest and nicest product, are the Swaar, the Snow, Baldwin and Willow Twig; and those which stand second are the Roxbury Russet, the Red Russet, the Westfield Seek-No-Further, and Greening; and third the Northern Spy, Minister and King apples. The product from the different evaporators varies in quality also. We find that with the American evaporator there is some danger from burning. This evaporator, having a coal furnace, has a good many advantages over a wood fire, which is used with the other evaporators, and it can run with very much less labor, but there has been some little trouble from burning. That, of course, can be overcome in a measure by careful management. The Topping evaporator is a very simple affair, which anyone can make, as I understand there is no patent upon it, and it gives the best product, and not a particle of burnt fruit. The Stahl produced a good deal of burnt fruit; unless very closely watched, some of the apples would become a good deal scorched, which results in considerable waste. If the business of evaporating is conducted on a large scale and on business principles, it cannot but be profitable; and tens of thousands of bushels, which otherwise go to waste when we have a large apple crop, would be preserved. In making these experiments we labored under the disadvantage of having no regular help, so that we feel that the cost of the products has been greater than it would be in the hands of practical business farmers or fruit growers. I will now take up the subject of the afternoon.

INSECTICIDES AND FUNGICIDES, AND THEIR PRACTICAL APPLICATION.

BY PROF. S. T. MAYNARD OF AMHERST.

In the good old times we are told that all the farmer or gardener had to do was to tickle the soil a little and it would laugh with an abundant harvest, unmolested by insect or fungous attack. This is the early history of all new countries. At first, in the virgin soil all crops grow with little labor, but sooner or later insect and fungous pests appear, and the cultivator of the soil must contest his right to the crop he grows, or move on to other new fields. As areas of any crop increase, the food supply for insects and fungi being more abundant, these pests increase; and there is hardly a crop that we grow that we do not have to wage prompt and earnest war to save from destruction.

It is claimed by the Bureau of Entomology of the Department of Agriculture that the injury from insects to all crops in the United States will reach $400,000,000 in a single year. But this is not the only loss to which the farmer is subject. It is estimated that the loss to our apple crop from fungous pests in a single year will amount to more than $10,000,000, to the pear and plum more than $50,000,000, to the grape $100,000,000; and so all along the line, including hay, grain, small fruits, vegetables and flowering plants, we could figure up almost inconceivable losses, until the amount might exceed that from insect injury.

At first a new pest increases at such a rapid rate that it seems to defy known remedies; but as the habits of the destroying insect or the nature of the fungus is more fully understood, we learn how the pest can be destroyed or the crop in some way protected from injury. Great progress has been made in the past few years in the knowledge of insect life and fungous diseases, and no sooner does a new destructive insect or fungus appear than the scientists connected with the stations in the various States vie with each other in throwing search-lights upon every possible phase of the subject, and soon we learn that by providing certain conditions or by the skilful application of certain remedies our crops can be saved. Not only do the station workers learn the best remedy or preventive for insect or fungous pests, but they often, by careful and extended experiments in the field, determine how to apply remedies in the cheapest and most effective way. This is "practice with science." It is hardly possible, however, for the stations, within the limits often available, to always settle these important questions. The practical, wide-awake business farmer, gardener or fruit grower must take the matter in hand and settle the question as to whether there is any profit in using insecticides or fungicides.

Our time is limited to-day, and we can only discuss a few of the most important insect and fungous pests, and the application of fungicides and insecticides for their destruction.

You are all more or less familiar with the history of insect life, and in this discussion no explanation of the terms used will be needed for a full understanding. Insects are generally visible, but fungous diseases cannot be seen by the unaided eye except by the results they show on the host plant; and a brief outline of the history of the development of a fungus may better enable us to understand each other.

A fungus is a minute plant growth, destitute of green coloring matter, which feeds by means of minute, thread-like, transparent roots, that penetrate the material affording it food. These roots, known as mycelium, are much like bleached cotton fibre in appearance. I can think of no illustration that will give one a better idea of their structure than this, very much reduced in size, of course, and aggregated, or compacted into close masses.

Fungi are divided into two groups, the saprophytic and the parasitic fungi; the first represented by the mushroom, and the second by the grape mildews, the grain rust or the potato blight. Taking the potato blight, which is more or less familiar to all as an illustration of a parasitic fungus, let us consider its life history. This fungus, like all others, starts from a seed-like body called a spore so minute as to be invisible to the naked eye except when seen in masses, and perhaps not more than one one-thousandth of an inch in diameter. One of these spores falls on the leaf, and under conditions of actual moisture, like a rain drop or heavy dew, in hot, close weather germinates, sending its roots, *i. e.*, the cotton-like threads, into the leaf, running through it and taking the nourishment, which the potato plant has elaborated for its growth and building it up into its own structure. When the fungus has matured its growth sufficiently, branches are thrown up through the other breathing pores, upon which are produced new spores in such numbers often as to give the surface of the leaf a rusty or powdery appearance. From the one spore mentioned may in a few days, if the weather is close and hot, be developed hundreds, even thousands, of new spores, which in turn, coming in contact with other leaf surfaces, grow and produce their increasing numbers, until in a very few days our potato vines have blighted, our grapes have been ruined by mildew, or our pear trees denuded of their foliage by the leaf blight, etc.

Most fungi produce two kinds of spores, one that we will call the rust or mildew stage, and the other the resting or winter spores. The first are of short duration, lasting only during the warm weather of summer; while the latter remain persistent through the winter, ready to germinate the next season, should conditions be favorable to their development.

The spores from which blights, rusts or mildews come may have been produced upon our own grounds, may have come from land miles away, or may have been developed upon some wild plant in the fields or woods; and the immense number of spores produced as illustrated by the dust from a dry puffball, makes it certain that there are spores enough at any time for the production of serious injury, if the conditions of weather are favorable.

The life history of this fungus illustrates, with more or less variation in structure and modification by the action of the host plant or conditions of weather, that of most of the common diseases of our farm and garden crops. While our crops will sometimes escape injury if we make no attempt to destroy the pests that attack them, it is not a wise policy to leave them to chance. It has been proved in many cases, yes, in most cases, by careful experiments, that the greater number of injurious insects and fungi may be destroyed or prevented from injuring our crops by the timely application of insecticides or fungicides. Many progressive farmers, gardeners and fruit growers have provided themselves with the most approved apparatus for the use of insecticides and fungicides, and spraying is as much a part of their routine as that of cultivation or fertilization.

FUNGICIDES.

Of the many substances suggested for the destruction of fungous pests, the Bordeaux mixture, from its cheapness, effectiveness and lasting qualities, has superseded all others.

Formula. — Copper sulphate, four pounds; caustic or quick-lime, four pounds. The copper sulphate or blue vitriol is quickly soluble in hot water, one or two gallons; or, if suspended in a basket or coarse sack in a tub or cask of cold water, it will dissolve in two or three hours. The *caustic* or *unslaked lime* is slaked slowly by adding small quantities of water until every particle of lime is reduced, and you have a thin paint or lime wash. When both liquids are cool they are mixed together, straining out the hard particles of lime by pouring through a fine-mesh sieve or burlap strainer. To this mixture is added water sufficient to make (*a*) twenty-five or (*b*) fifty gallons, as may be desired. The agent of destruction in this mixture is probably the very minute quantity of copper precipitated by the union of the two substances, and which is held upon the surface of the plant by the lime, ready to destroy or prevent germination of the fungus spores. It is known that fungus spores cannot germinate on the surface of copper vessels, and that one part of free copper in ten million parts of water will also prevent the germination of the spores of many kinds of fungi. But, whether it be the small quantity of free copper sulphate in the solution, the hydroxide of copper, or something not quite understood as yet, we do know that the use of this substance when properly prepared is the most effectual fungicide for general use. Where large quantities of the mixture are needed, twenty-four pounds, forty pounds, or any proportionate amount, may be prepared; but each must be kept separate, and where evaporation shall not be very great. When needed for use the proper quantity of each is taken, and, after thoroughly mixing, poured together.

In cases where the Bordeaux mixture will disfigure the fruit, the *ammoniacal carbonate of copper* should be used; but it is so quickly soluble and washed off by rains that more frequent applications must be made, and injury to the foliage is more likely to result than from the use of the Bordeaux mixture.

Formula.—Copper carbonate, three ounces; ammonia enough to dissolve the copper; and water, forty gallons. Dissolve the copper carbonate in ammonia, using only enough to dissolve all the powder, then dilute to forty gallons before using. (*The ammonia found at drug stores often varies so much that the exact quantity cannot be given.*) Larger quantities of the copper carbonate may be dissolved at one time, if desired, but it must be kept in glass-stoppered bottles.

INSECTICIDES.

Of the many insecticides I shall confine myself to the two most in general use, *i. e.*, Paris green and kerosene emulsion. We use Paris green for the destruction of chewing or leaf-eating insects, because of its uniform quality, and that it is not so likely to injure the foliage as is London purple. In water alone it cannot be used with safety stronger than one pound to two hundred gallons; but if lime be added to the water, or if the Paris green is combined with the Bordeaux mixture, it may be used as concentrated as one pound to fifty gallons. For sucking insects the *kerosene emulsion* has proved more satisfactory than any other preparation.

Formula.—Dissolve one-half pound of any common bar soap in one or two gallons of hot water; while still hot add two gallons of ordinary kerosene, and with a syringe or hand pump stir the liquid until a paste or lardlike substance is formed. When used, this may be diluted so as to produce (*a*) fifteen and (*b*) twenty-five gallons of liquid.

As most of the insects and injurious fungous growths appear at the same time, it has become the practice to combine Paris green and the Bordeaux mixture, so that one-half of the cost of application is saved; and, as the lime in this mixture neutralizes the free arsenious acid, should there be any, more of this insecticide can be used, thus making the destruction of insect pests more certain.

Spraying Pumps.

For the application of fungicides and insecticides there are manufactured in various sections many kinds of pumps, of greater or less perfection of construction. A pump to be satisfactory must be one that will throw a steady stream with considerable force, and yet work with ease. Such pumps are manufactured by W. & B. Douglas of Middletown, Conn., the Field Force Pump Company, Lockport, N. Y., and numerous other parties in different parts of the country, most of whom are making good pumps, but which of them is the best is difficult for any one to determine. The value of a pump of any of the various makes often depends very largely upon the manipulator. A complicated piece of mechanism requires a mechanic to run it properly and keep it in good working order, and the best machine ever made may soon be rendered useless in the hands of a bungler.

We have here on exhibition from W. & B. Douglas and the Field Force Pump Company several forms of pumps. The knapsack pump is very serviceable for small gardens, small trees and closely planted crops, where a team cannot be driven; but the cost is against its general use. The barrel pump or the power pump is much more economical of time and labor, where a large amount of spraying is to be done. The settling of the solid parts of the Bordeaux mixture and the Paris green has been one of the difficulties met with in ordinary spraying, and we are glad to note that the appliances for automatically stirring the mixtures have been attached to the newer forms of both the knapsack and the barrel pump.

In discussing the subject of insecticides and fungicides we cover a very large field, and in order to include all of the important fungous diseases and destructive insects I shall be obliged to take them up in groups, considering both the insects and the fungi injuring each crop together; and time will permit only of a brief mention of the characteristics of each.

The Apple.

Attacking the apple we have the larvæ of the codling moth (*Carpocapsa pomonella*), the tent caterpillar (*Clisiocampa americana*), the bud moth (*Tmetocera ocillana*), the fall canker worm (*Anisopterix pometaria*), the spring canker worm (*Paleacrita vernata*), the apple maggot (*Trypeta pomonella*), the plum curculio (*Conotrachelus nenuphar*) and the apple curculio (*Authonomus quadrigibbus*).

The *codling moth* is a small gray moth that flies in the night and lays its eggs in the calyx or blossom end of the apple just about the time the petals are falling; the larvæ or worms penetrate the apple and feed upon its tissue, generally causing it to drop or ripen prematurely. After reaching its full growth the larva comes out of the apple and makes its cocoon under the bark of the tree, on fence rails or any dry substance that will afford it some protection.

The *tent caterpillar* moth is larger than the codling moth, of a gray-brown color, and lays its eggs in clusters around the twigs toward the ends of the branches of the apple, peach, wild cherry and some other trees. The eggs hatch in May, and the larvæ form webs in the forks of the branches. After completing its growth the larva makes a cocoon on dry substances, like rails, boards, stones, etc., and comes out the following autumn to continue its round of life.

The *bud moth* is very small, and lays its eggs in the buds of the apple and pear, the larvæ eating out the centre of both leaf and flower bud, and often causing serious damage.

The *canker worm* moths, of which there are two species, are light gray in color, the male having wings, while the female has none, and must crawl up the tree where it lays its eggs. Both species come out on warm nights, when the ground is unfrozen, more or less from November 1 to May 1. These eggs hatch early in the spring, as soon as the leaves have unfolded sufficiently to furnish food for the larvæ, which feed voraciously up to about June 10, when they spin a thread and swing down to the ground, where they make their cocoon and undergo their changes.

The fall and spring canker worms are very much alike in habit, except that most of the former come out and lay their eggs in the fall under favorable circumstances, while the latter generally do not lay their eggs until toward spring.

The *apple maggot* is a small brown fly, about one-half the size of the house fly, that we see in large numbers around piles of cider apples, and which lay their eggs in the apple by puncturing the skin. It attacks the mild acid and sweet apples more than the more acid varieties.

The *plum curculio* and *apple curculio* are small beetles from one-eighth to one-fourth of an inch long, with projecting mouth-parts something like the trunk of the elephant. The former makes a crescent-shaped mark under the skin, in which it lays its eggs, while the latter makes a deeper round hole, laying an egg at the bottom. The eggs of the apple curculio hatch and the larvæ mature in the apple, while that of the plum curculio seldom matures, but the effect upon the fruit is the same, — an irregular growth, the apple being checked at the point attacked, while the remainder grows on, and we have gnarly or uneven apples.

The fungi injuring the apple are the apple scab (*Fusicladium dendriticum*) and the apple rust (*Roestelia aurantiaca*). The *apple scab* is a dark olive-green or almost black fungous growth, that causes the scabby apples. When it appears early in the season it checks the growth at the point of attack, and gnarly apples result; but if the attack is as late as August or September the fruit is simply disfigured. When the leaves are largely covered with this apple scab they turn yellow and fall off. The *apple rust* only attacks the leaf, its first appearance being small yellowish-brown spots. As these increase in size and number the leaf is so injured as to cause it to fall off.

The insects and fungi attacking the apple, with the exception of the apple maggot, are destroyed by the combined use of the Bordeaux mixture and Paris green.* The routine for the season is as follows: *first*, just before the leaves have unfolded, spray with the Bordeaux mixture (*a*) and Paris green, one pound to one hundred gallons; *second*, just before the petals open use mixture (*b*) with one pound

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* See Bulletin No. 25, Hatch Experiment Station.

Paris green, one pound to one hundred gallons; *third*, as soon as the petals have fallen, spray again with same mixture; *fourth*, in from two to four weeks spray again with mixture (*b*) without the Paris green. Should the season be very moist and warm, a fifth spraying may be needed during July.

The spraying done just before the blossom buds open is for the destruction of the canker worm, tent caterpillar, codling moth and plum and apple curculio; and, the larger the amount of Paris green that can be made to adhere to the leaves and blossom buds, the more certain the destruction; and if thoroughly done it is entirely effectual. The third spraying is principally for the codling moth, but any canker worms or tent caterpillars that may remain will be destroyed.

On trees too large to be reached by the spray from an ordinary pump like the elm, the canker worms may be destroyed by using bands of tarred paper, *fitted closely* around the tree, so that no insects can crawl under, covered with soft gas tar or printers' ink. These bands should be put on by the middle of October, and some seasons possibly by October 1. At all times from this date to May 1 *when the ground is not frozen* and the temperature of the nights is above freezing, this tar or ink must be kept moist and sticky; and if at any time the insects accumulate on the tar so as to form a bridge over it, more must be added. Generally three or four applications are all that will be needed to prevent injury from this insect. No remedy is known for the *apple maggot* except to destroy all affected fruit by feeding, or making it into cider. If the fruit be picked while yet hard, very few of the apples will be much injured by this insect, as it does not lay its eggs in the fruit until it is nearly mellow.

THE PEAR.

The codling moth (*Carpocapsa pomonella*) and the pear tree *Psylla* (*Psylla pyri*) are the two insects most injurious to the pear. The codling moth I have already described under the apple. The pear tree *Psylla* is a minute insect, so small as to be difficult to see. It takes several forms during the season, sometimes being winged and sometimes with only rudimentary wings. It first appears in the axils of the leaves, sucking the juice from the leaf stalk; then increasing, it spreads over the surface of the leaf and the stem, often making little pools of juice or exudations, sometimes called honey-dew. This liquid is syrup-like, and catches the particles of dust from the air, and a black fungus develops rapidly in it, so that the trees are enveloped with a dirty black covering. Another indication of the presence of the pear tree *Psylla* is the large number of flies, wasps, hornets and bees that surround the trees attacked. The remedy for this insect is spraying with the kerosene emulsion (*a*): *first*, as soon as the leaves begin to unfold; *second*, from one week to ten days later; and a *third* spraying in two weeks if any of the insects remain alive.

The fungi attacking the pear are the leaf blight (*Entomosporium maculatum*) and the fire blight (*Micrococssus amylovorus*). The *leaf blight* first shows itself in small reddish-brown spots on the leaf or fruit during hot, moist weather, and if these spots increase in size and number the leaves fall off or the fruit becomes cracked, as often seen in the Flemish Beauty and other varieties. This fungus is prevented from injuring our pear trees or fruit by spraying with the Bordeaux mixture used as for the apple.

The *fire blight* is a disease which causes the twigs and sometimes large branches or even the whole tree to turn dark brown in a day or two. It also attacks the end twigs of the quince. While the Bordeaux mixture will have no effect upon the growth of this disease after the germs have got into the tree, we feel sure that if they come in contact with this substance they will be prevented from growing.

PEACH, PLUM AND CHERRY.

The stone fruits we may group together, although they are not all attacked by the same fungi.

The most destructive insect attacking the plum, peach and cherry is the plum curculio (*Conotrachelus nenuphar*). This insect is a small brown beetle, attacking all the stone fruits, and laying its eggs in a crescent-shaped cut very soon after the petals have fallen. It feeds on the leaves, and the use of the Bordeaux mixture and Paris green has been found a satisfactory remedy. Whether the effectiveness of the remedy is from its offensiveness, causing the insects to seek other fruits in which to lay its eggs, or whether the Paris green kills them, is difficult to determine.

The fungous diseases attacking the plum, peach and cherry are the brown rot (*Monilia fructigena*) and the leaf blight, (*Clindrosporium padi*); attacking the plum and cherry, the black wart (*Plowrightia morbosa*); attacking the plum and peach, the scab (*Cladosporium carpophyllum*); attacking the peach, the leaf curl (*Taphsina deformaus*) and the peach yellows.

The *brown fruit rot* is a fungus attacking all the stone fruits, more or less, about the time they are nearing maturity, although in some cases it appears earlier. The fruit first turns brown in color and then becomes studded over with lighter brown spores in masses. It is most destructive during moist, warm weather, and especially if the trees are planted closely or in shaded gardens. On light land and when fully exposed to good currents of air and plenty of sunshine it is less destructive.

The *leaf blight* first appears as small brown spots on the leaves; under favorable conditions these increase in number and size until the leaves fall off prematurely, often in July or August, causing serious injury.

The *plum* and *peach scab* is an olive-green fungus, causing spots on the fruit. When it appears early in the season the fruit is checked in growth at the point of attack, and it cracks much as the pear cracks when attacked by the leaf blight fungus.

The *leaf curl* appears on the peach soon after the first leaves are formed, causing them to swell or puff up. They soon drop off, however, and new leaves appear, and the tree seems but little injured by its attack.

For the destruction of the plum curculio and the above-mentioned fungi the following routine is suggested: *first*, spray just before the leaves unfold with Bordeaux mixture; *second*, spray just after the petals have fallen with Bordeaux mixture (*a*) and Paris green, one pound to one hundred gallons; *third*, spray in a week or ten days, according to weather; if rain has fallen within one week, the shorter interval; if not, the longer period, with Bordeaux alone; *fourth,* in from two to four weeks spray again with last mixture; *fifth,* just as the fruit begins to color, with the ammoniacal carbonate of copper.

The *black aphis* (*Myzus cerasi*) is destroyed by the kerosene emulsion, formula (*a*), applied with all the force possible to get it in among them on the curled inside of the leaves.

The *yellows* is a disease the nature of which has for a long time baffled the investigations of scientists and the skill of the practical growers. The summary of all the reports as to the nature of this disease is about this, — "We don't know." We do know, however, that under certain conditions our peach trees have a sickly yellow color, the fruit ripens prematurely, is highly colored and often of a bitter taste. Small wiry shoots start out in clusters on the trunk or branches, and the tree finally dies.

No specific fungous growth or bacterial germs have been proved to be the cause of these conditions; but the disease may be brought on by exhaustion of the soil, by overbearing, by poor cultivation, by injury from the winter, and the peach borer. When taken in time, the trees may be saved by good cultivation, proper fertilization and pruning. It may not be profitable to undertake this remedy; and the "heroic treatment," that of digging up and burning all diseased trees as soon as they show advanced stages, is probably the safest and best. This remedy is made compulsory by law in several of the States of the Union. Young trees cost but little, and will grow to produce fruit in Massachusetts in from three to five years.

THE GRAPE.

The only insect seriously injurious to the grape is the *rose bug* or *rose chaffer* (*Macrodactylus subspinosa*). This insect is known to every one who cultivates the rose. It lays its eggs in the ground during the month of June. These eggs hatch and feed upon the young, tender roots of various kinds which it finds in the soil, makes a cocoon and comes out a perfect insect the following summer. It appears just at the time the grape blossoms open, and they are found in pairs feeding on the leaves or blossoms, but preferring the latter.

The fungi injurious to the grape are the black rot (*Læstadia Bidwellii*), the downy mildew (*Peronospora viticolor*) and the powdery mildew (*Uncinula spiralis*).

The *black rot* attacks the fruit, causing it to turn brown and then black, and if attacked early in the season the berries dry up and adhere to the stems, but when appearing later the berries turn brown and drop from the stems.

The *powdery mildew* attacks the leaves during close, moist weather, in the latter part of summer, causing them to turn yellow and often fall off.

The *downy mildew* attacks the grape leaves in the same way as the last, but generally earlier in the season, having the same effect. Such varieties as the Delaware, Rogers Hybrids and other tender sorts are especially liable to its attack.

A partial remedy for the *rose bug* and a complete one for the above fungi is found in the Bordeaux mixture and Paris green, one pound to one hundred gallons, application to be made as follows: *first*, spray just before the buds burst in spring; *second*, spray just before the blossoms open; *third*, spray as soon as the petals have fallen, which is generally in from three to five days; *fourth*, spray with the Bordeaux mixture alone once in from two to four weeks until the grapes are nearly grown. If very moist, warm weather should continue, the ammoniacal carbonate of copper should be used once or twice during August.

THE CURRANT AND GOOSEBERRY.

The currant borer (*Ægeria tipuliformis*), the cane girdler *Phyllœcus flaviventris*) and the currant worm (*Nematus ventricosus*) are the most destructive insects attacking the currant and gooseberry. The fungi are the gooseberry rust or mildew (*Sphœrotheca mors-uvæ*) and the currant leaf spot (*Septoria ribis*).

The *currant borer* is a small, wasp-like moth, that lays its eggs in the young canes during the early summer. These hatch, and the worm or larva bores into the cane, feeding on the pith. When it has matured it works near the outer bark, and then, after undergoing its changes, comes out the following spring to lay its eggs in other canes.

The *cane girdler* is a small brown insect that lays its eggs in the young tender shoots, and then makes a row of incisions on a circle above where the eggs are laid. This causes the cane to break off and wither, and thus the young are supplied with more abundant food. The larvæ eat into the cane, feeding on the pith, like the cane borer.

The *currant worm* insect is a small *saw fly* that lays pearly-white eggs along the midribs and veins of the currant and gooseberry leaves very soon after they have unfolded. These soon hatch, and eat small round holes in the leaf, coiling themselves on the edges of these holes. They feed very rapidly, and in a few days reach full growth, when they leave the denuded bushes and make their cocoons, to come out in a short time to lay a second brood of eggs. The first brood are generally found on gooseberry bushes, if any are growing near the currant bushes; and by treating those alone the labor of destruction is much reduced.

For the currant borer and cane girdler no remedy has been discovered save that of cutting off the injured canes and burning them.

The currant worm is easily destroyed by dusting with Paris green *up to the time the fruit is half grown, after which it will not be safe to use it.* A safer remedy is to dust the bushes with powdered hellebore when they are wet, or apply it in water, one tablespoonful to a gallon. After the fruit is nearly ripe it may be safer to use the pyrethrum or Persian insect powder, applied just before night.

The *gooseberry mildew* or rust attacks this fruit often, and sometimes the currant, both leaf and fruit, giving them a powdery or mealy appearance. It is especially injurious in closely planted gardens.

The *leaf spot* attacks the leaves of the currant, first appearing as small brown spots, in July or August. If these spots are numerous enough, the leaves turn yellow and fall off, leaving the bushes bare the rest of the season, and seriously checking their growth.

These two diseases are prevented by the Bordeaux mixture, applied thoroughly: *first,* as soon as the leaves are fully formed; *second,* as soon as the fruit has set; *third,* as soon as the fruit has been gathered. If the anthracnose or leaf-spot should appear on the leaves while the fruit is ripening, an application of the ammoniacal carbonate of copper should be made.

RASPBERRY AND BLACKBERRY.

The insects attacking these fruits are the root borer (*Ægeria rubi*), the cane borer (*Oberea bimaculata*) and the snowy tree cricket (*Œcanthus niveus*). The fungi are anthracnose (*Glœosporium venetum*), the raspberry leaf blight (*Septoria rubi*), the spring orange rust (*Cœma niteus*) and the fall orange rust (*Chrysomyxa albida*).

The *raspberry root borer* lays its eggs in the young canes; these hatch, and the larvæ then bore down through the cane to the root.

The *cane borer* lays its eggs in the new canes, and the larvæ girdle them, causing the top to wilt. They then bore into the cane and prevent full growth.

The *tree cricket* is a beautiful light-green insect, with lace-like wings. It lays its eggs in the canes in long rows, splitting it for this purpose. The young are beneficial by feeding upon plant lice, but the perfect insect sometimes causes much damage in laying its eggs.

The only remedy for these insects is destroying the infested canes or roots.

The *anthracnose* attacks the stems and leaves of the raspberry, its first appearance being small spots with reddish borders. As these increase, the growth of stem is checked, and the leaves, especially the lower ones, fall off.

The raspberry *leaf blight* comes on about the time the fruit is ripening. At first small round spots are seen; these increase in size and number, and the leaves fall off, so that by the first of September we often have only a tuft of fresh leaves at the top of the cane.

The *spring orange rust* appears on the blackberry and blackcap raspberry. At first the leaves appear stunted in growth only, but soon there appears a mass of most beautiful golden spores on the under surface. It is largely confined to one or two varieties, and is most injurious on neglected plantations.

The *autumn orange rust* is of recent origin with us. In color it is like the spring form, but does not grow in such compacted masses. It has been found largely on the Agawam blackberry and some of the red raspberries. It appears late in the summer or early autumn, and if in such abundance as it has appeared this fall will seriously affect the growth of the varieties attacked.

For the prevention of these three fungi we would spray: *first*, just before the leaves unfold, with the Bordeaux mixture, taking care to wet every cane thoroughly; *second*, when the leaves have unfolded and just before the blossoms open, spray with the same. Should the raspberry leaf blight appear before the fruit is gathered, one spraying must be made with the ammoniacal carbonate of copper; but if it does not appear, no further application need be made until the fruit is harvested, when a *thorough spraying* with the Bordeaux mixture will prevent the spread of this disease and the fall orange rust.

STRAWBERRY.

The larvæ of the May beetle (*Lachnosterna fusca*) and the black paria (*Paria aterrima*) are the two most injurious insects attacking the strawberry; and the strawberry leaf blight (*Sphœrella fragariœ*) is the only well-known fungous disease.

The *May beetle* lays its eggs in turf land, old strawberry beds, weedy land and under trees and shrubs, where the larvæ will find an abundance of young and tender roots to feed upon, and never in clean, well-cultivated ground. From the time the eggs are laid to its full development into the beetle state it requires two or three years, the larvæ feeding all this time, and doing much injury.

The *black paria* lays its eggs near the crown of the strawberry plant, the larvæ feeding on the roots, while the perfect beetle feeds on the young leaves, making small punctures like shot holes.

The strawberry *leaf blight* first appears as small reddish-brown spots on the leaves, which, if abundant, as they are on many varieties long in cultivation, seriously check the growth of the plant, and the fruit is of small size. It may appear at any season of the year if the weather is favorable, but generally appears near fruiting time and during July and August.

The remedy for the larvæ of the above insects is rotation, planting only on land that has been clean-cultivated at least two years to escape the May beetle, and not planting two seasons consecutively on the same land to escape the black paria.

To destroy the black paria in its beetle form, and also the leaf blight, the Bordeaux mixture and Paris green, one pound to one hundred gallons, should be used: *first*, as soon as the growth begins in the spring, throwing the liquid down among the crowns of the plants with as much force as possible; *second*, spray just before the blossoms open, with the same.

As soon as the fruit has been gathered, it will be more profitable to turn under the plants at once, thus checking the development of this insect. The new plantation, which should have been planted in the spring and some distance from the fruiting field, must be sprayed with the Bordeaux mixture and Paris green two or three times during the summer to keep the paria and leaf blight in check.

POTATO.

Of the insects and fungi attacking the potato, the Colorado beetle (*Doryphora decemlineata*) needs no introduction or description, and the potato blight and rot (*Phytophthora infestans*) is also more familiar to you than is pleasant to contemplate. The former is destroyed by Paris green and the latter by the Bordeaux mixture. With a barrel pump the combined mixture, one pound to one hundred or two hundred gallons, may be applied very cheaply, and both pests kept under control. The Victor pump is arranged so that five rows may be sprayed at one time. In our experience with this pump, however, two nozzles in the hands of a quick man walking behind it will distribute the materials to better advantage than by the fixed nozzles; for, if the rows are not very even in distance, some of the foliage will be left unsprayed. With the ordinary barrel pump, if two nozzles are used, one man walking behind or sitting in the cart may cover eight or even ten rows at one time. The *first* application should be made as soon as the larvæ of the potato beetles begin to appear. Subsequent applications must be made at intervals of from one to three weeks, according as the insects increase or as the weather may be favorable or unfavorable for the growth of the blight or rot.

CELERY.

Attacking the celery we have the celery caterpillar (*Papilio asterias*), the celery leaf blight (*Septoria petroselini var. apii*) and the celery leaf rust (*Cercospora apii*).

The *celery caterpillar* seldom does much injury, and is destroyed by hand picking. The *rust* and *leaf blight* are more common, and often cause serious injury. They both come on in hot, dry weather, and especially where the supply of plant food is small or reduced by the lack of moisture in the soil to render what there is soluble.

The treatment of these diseases with the Bordeaux mixture has not been productive of quite satisfactory results; yet it is believed that if the plants are sprayed in the seed bed, and then two or three times after planting in the field, much benefit will result. When either of these diseases appear, if deep cultivation is practised by means of the plough or deep-working cultivators close up to the plants, and some quick-acting fertilizer is applied, the plants generally recover and grow to maturity without further injury.

CABBAGE.

The cabbage worm (*Pieris rapæ*) is the insect most destructive to the cabbage, and the club root (*Plasmodiophora brassicæ*) the most troublesome fungous growth.

For the *cabbage worm* we find pyrethrum or Persian insect powder, if fresh, extended by adding twenty to fifty parts of air-slacked lime or flour, and dusted into the head with the common sulphur bellows, a certain, harmless and cheap remedy. Paris green *may* be used until the heads *begin to form*, but *after that time is dangerous*, and at any time *we would not advise its use* unless absolutely necessary.

The *club root* is a fungous growth that causes the tubercles or swellings on the roots of the turnip and cabbage, and is propagated on the roots of many other cruciferous plants, like the mustard, shepherd's purse, etc. It also propagates in composts that contain any waste of cabbage or turnip.

The spores also remain in the ground upon which any of these crops have been grown, and if either the turnip or cabbage is planted on land manured with cabbage-waste compost, or where a previous crop has been a cruciferous one, it is sure to be attacked. As this fungus grows under the ground, no ordinary fungicide will reach it, and the only remedy we have is not to plant the cabbage on land where any other cruciferous crop has been grown for at least two years.

Success in the application of liquid fungicides or insecticides depends very largely upon how thoroughly the surface of the plants sprayed is covered, and how much of the material remains fixed. To obtain these results, a nozzle must be used that will break the stream into a very fine spray or mist. Among the nozzles that accomplish this result may be mentioned the many forms of the Vermorel, the Stott, the McGowan and the Gem.

When plants are growing rapidly, more frequent applications of fungicides or insecticides need be made than after the growth is more fully completed, as a leaf that is in the bud to-day, to-morrow may be fully expanded and exposed to the dangers of insect or fungous attack. The expense of spraying is very small, even when done on a small scale; and when the most approved appliances are used and larger areas are sprayed, as may be done by co-operation in villages or towns, or by some one person setting up in the business to protect neighborhood crops, the expense can be greatly reduced. Without the use of fungicides and insecticides, however, very few of our crops can be made certain.

Mr. Stanley. I have had some experience in fruit raising, and have found nothing better than air-slacked lime for the curculio. Some say that wood ashes are equally good. The lime should be sifted over the plum trees daily for at least three days, beginning when the bloom appears. Some people cannot readily obtain the Bordeaux mixture, but air-slacked lime is always to be had.

Mr. Hill. Air-slacked lime undoubtedly has some effect, and covering the trees with any dust will do something toward protecting the crop from the curculio; but we have two forms of leaf blight that sometimes destroy every leaf on the tree before the fruit is matured, and the lime will have no effect on the blight. The application of the Bordeaux mixture is effective for the curculio and also for the blight.

Mr. Stanley. Not everyone has this mixture.

Mr. Hill. They can make it.

The Chairman. I tried air-slacked lime thoroughly thirty-five years ago. I followed it up for several years, but it was a complete failure.

Mr. Hill. I have grown plums and other fruits for many years. I have tried air-slacked lime, wood ashes and road dust, having seen them recommended, but they all failed in every instance. The Bordeaux mixture is effectual. I think road dust just as good as lime, and either may be of some use in driving the insects away, but neither is of any value in destroying blight or fungus.

Question. What would you do with the black cherry? I understand the black knot has been on the black cherry ever since the country was settled.

Professor Maynard. I never saw it on the black cherry. It is very common on the red choke-cherry and it sometimes appears on our cultivated cherries. At the college for ten years past we have had full crops of plums every bearing year. There is no difficulty in growing plums and cherries if you will follow up the spraying.

Mr. ——. I have found hellebore useful for the currant worm. I have used it clear and with one-half finely sifted coal ashes, also with three-quarters coal ashes. In each case it was equally effectual.

Professor Maynard. The currant worm is a very delicate insect, and coal or wood ashes or road dust will often destroy it when it first hatches out, but hellebore is sure death to it.

Mr. Hill. If it is applied when the worms first appear, a weak solution in water sprinkled into the centre of the bush will destroy them. But I wished to ask what would be the difference in the product of evaporated apples from a bushel of Snow apples and a bushel of King apples.

Professor Maynard. I think the Snow apple would give one or two pounds more of the dry product, and it would be of much the best quality.

QUESTION. If the Bordeaux mixture is applied to potatoes, would an ordinary shower wash it off?

Professor MAYNARD. If properly made, one spraying will be visible nearly all summer; but as the plant grows new leaves unfold, and there is a source of danger.

QUESTION. Does the fungus attack both sides of the potato leaf?

Professor MAYNARD. Yes, but usually it is found on the under side.

QUESTION. Are these spraying pumps sufficiently powerful to spray the highest elms?

Professor MAYNARD. Not without carrying the hose up onto the tree.

Mr. LUNT. Some years ago the leaves of my plum tree were badly eaten by the May beetle. They fed only by night, burrowing in the ground during the day. I found also that they did not stick to one tree, but would be on one one night and the next night might attack one at a considerable distance from the first. On this account it would be difficult to kill them by spraying. I also noticed them on forest trees near by. Ash trees were completely stripped of their foliage. Can you suggest a remedy for this pest?

Professor MAYNARD. No effectual remedy has been found for the May beetle, or the June beetle, as it is usually called. They work upon the chestnut, the elm, the ash, the hickory, as well as upon the plum, and seem sometimes to be everywhere in immense numbers. Sometimes you may find their larvæ so numerous in turf land that you can dig them out by the bushel. Mr. Hunnewell of Wellesley had such an experience.

The CHAIRMAN. Some fifteen years ago I had charge of a fine lawn that had been made some five or six years. The creatures were numerous enough to almost destroy it; it seemed perfectly bare of all vegetation. I decided to wet it down thoroughly, as we had an abundance of water. We then took pounders and pounded it down well, so that the sod was driven into the ground. In a few days green grass appeared and the lawn was saved. Whether the pounding killed the larvæ I do not know, but the experiment was a success.

Mr. Hill. Did you tell us what causes the potato scab and what is a remedy for it?

Professor Maynard. I did not. It is impossible to treat of every pest in one short paper. It has been recently proved that the potato scab is caused by a minute fungous growth, the spores of which remain in the soil where potatoes have been raised or are carried to the field in compost. This has been remedied or prevented by soaking the seed potatoes in a solution of corrosive sublimate; I think about nine ounces to fifteen gallons of water is the proper proportion. The potatoes may be put in a basket and immersed in the solution, remaining long enough to saturate the scabs, then taken out and dried and another lot put in. As the solution will be decreased in quantity by every lot put in, it is first made stronger than is necessary, and as it grows less in quantity may be increased by adding more water. It has been proved to be a perfect remedy even if the potatoes are planted on land where the spores are present. Land that has not been planted with potatoes for several years is usually free from the spores unless they are carried to it in the compost or on the seed planted.

Mr. Hill. Is it well to rake up the dead leaves from an orchard and burn them, to destroy the spores of fungus that may be upon them?

Professor Maynard. It is a good thing to do; but such spores are in forest leaves as well as in the leaves of fruit trees.

Mr. Hill. I like to use the dead leaves for mulch around my raspberries and currants.

Professor Maynard. These spores are very minute and may be lodged anywhere and everywhere, and only a small part can be destroyed by burning. The better way is to spray trees and plants with fungicides at a proper time, and so destroy them.

Mr. Hill. I always spray the ground and mulch under my bushes and trees when I spray the green leaves. You have not spoken of the quince. It is very much affected in this section with red rust.

Professor Maynard. The fire blight does the most damage to the quince. There are also two or three forms of rot which attack the fruit, beside the red rust. These are mostly controlled by application of the Bordeaux mixture.

Mr. Williamson. Will the professor tell us whether it is safe to pasture animals under trees that have been sprayed with Paris green, or to feed the hay mown under such trees?

Professor Maynard. There is little or no danger. The quantity of the poison that an animal can get in that way is not sufficient to injure it, unless the settlings are spilled upon the grass.

Question. Is there any necessity for spraying apple trees in the fall of the year?

Professor Maynard. No, sir.

Secretary Sessions. I wish the professor would tell us how to deal with the canker worm, what to do now, next month, and so on until it disappears next season.

Professor Maynard. The indications are that we shall have trouble from the canker worm in many places in the State next spring. The season has been very favorable for its development, and we find that they are already beginning to fly in the warm nights. Bands of tarred paper should be placed around the trees as early as the first of November. The loose bark should be removed where the bands are to be placed, and the bands should be made tight about the tree, using short tacks. The bands should be painted over with Morrill's tree ink, which is on sale prepared ready for use. It should be kept fresh by repeated applications, except when the weather is quite cold. While the ground remains covered with snow there is no danger, but when there is a thaw or warm spell of weather the moths come out of the ground and ascend the trees. At such times it is imperative that the bands be kept moist with the tree ink. This must be continued until the first of May. From about May 1 to near the middle of June the caterpillars are at work on the foliage; then they spin down on thin threads and enter the ground, where they form their cocoons and remain in the chrysalis state throughout the summer and early autumn.

Mr. Doane. This section has been for years infested with the canker worm. It used to be the general practice to use printers' ink, but we never succeeded in keeping down the canker worms.

Professor Maynard. You were not on time.

Mr. DOANE. Of late we have sprayed with Paris green when the time comes, and are able to get rid of them without much trouble.

Professor MAYNARD. But you cannot spray the lofty elm trees.

Mr. DOANE. I have two large elms in front of my house, and tar has been tried on them, and it did not save them from the canker worms.

Professor MAYNARD. Did you put tar or ink on as early as November 1, and keep it in proper condition until May 1?

Mr. DOANE. It seemed as if we were putting it on all the time.

Mr. WOOD. Three years ago I was troubled very much with canker worms, I got rid of them, but they came again and again. I have tried spraying with an improved kind of pump, and I cannot seem to kill them. This fall I began tarring early. I have one thousand fruit trees. I have caught other insects beside the canker worm on the bands. I have not succeeded to my mind with the spraying, but believe that it pays well to band the trees fall and winter. Will the professor tell us what is the home of the little insect about the size of a knitting needle, somewhat like the canker worm, only smaller, of which I caught a great number before I began to catch canker worms?

Professor MAYNARD. It is probably the fall canker worm. The fall canker worm is very much smaller than the spring.

Mr. WOOD. What becomes of the grub or moth after it has laid its eggs?

Professor MAYNARD. It lives but a short time after it has laid its eggs. If we band our trees for the canker worm, we will still have to spray for the codling moth and the apple scab. This same spraying will answer for the canker worm on all fruit trees.

QUESTION. If the tarred paper bands are left on the trees through the summer, will the trees be injured?

Professor MAYNARD. The tarred paper will sometimes injure the thin bark of young trees. There is no danger to old trees. Printers' ink is not so likely to injure the tree as the ordinary tarred paper.

Mr. THURLOW. I have had a great deal of experience with printers' ink. My father had a large orchard forty or fifty years ago, and the canker worms attacked the trees. We tried various remedies, but it was printers' ink that finally exterminated them. I made a careful estimate of the yearly cost, and it was four cents a tree. The trees are now larger and it might cost more, but I am sure that eight cents a tree would cover the cost now. I think the bands should be put on as early as the middle of October. They certainly do sometimes go up before the first of November. I have tried spraying, but it did not answer the purpose, the worms were not killed, but the leaves were injured; perhaps the man whom I employed did not understand just how to do it. But I have gone back to the paper bands. Morrill's and Donald's inks are both perhaps equally good. Both have been improved, and are sold at a low price. We put the ink in bottles, leave them in the sun during the forenoon, and the heat of the sun will warm the ink so that it will spread easily. We put it on after dinner. It should be applied liberally near the top of the bands, and does not need to be diluted. After a rain or exposure for some time to bright sunshine it needs to be renewed. I should take the bands off as soon as the insects have got through running. I believe the shade trees of this city can be best protected by printers' ink. They are too tall for spraying, and the cost for large trees will not be great. I do not antagonize improvements, I believe in spraying; but for myself I think I can manage the canker worm best by the bands of printers' ink.

QUESTION. Does the estimate of eight cents per tree include the cost of labor?

Mr. THURLOW. It includes the cost of everything.

Mr. ——. I put on tarred paper this past fall about October 1. I caught nothing until the middle of the month, when I began to find it of use. I should think it ought to be put on earlier than November 1.

Secretary SESSIONS. These lectures and discussions will be printed in the "Agriculture of Massachusetts" for 1894. The volume will be ready for distribution about April 1. They may be obtained of your Senators and Representatives, who have twenty-five copies each for distribution. Copies are also sent to the agricultural societies, granges and farmers' clubs, to be distributed to farmers and fruit growers. If any gentleman fails to get one from any of these sources, he can be supplied by applying to the secretary of the Board of Agriculture, Commonwealth Building, Boston. The State prints 15,000 copies, and every man who desires should have one. In behalf of the Board of Agriculture I thank the people of Newburyport for their cordial reception of the Board, and the people of the vicinity for the good audiences and the respectful attention given to the proceedings of this meeting. I hope you may remember the Board of Agriculture with pleasure, and give it God-speed in accomplishing the work for which it was created by the Commonwealth of Massachusetts.

The CHAIRMAN. In closing this meeting, I wish to say that I think it is the opinion of the Board of Agriculture that the series of meetings in Newburyport has been one of the most interesting and profitable that the Board has ever held, and I now declare the meeting adjourned.

FOURTH ANNUAL REPORT

OF THE

DAIRY BUREAU

OF THE

MASSACHUSETTS BOARD OF AGRICULTURE,

REQUIRED

UNDER CHAPTER 412, ACTS OF 1891.

JANUARY 15, 1895.

Commonwealth of Massachusetts.

OFFICE OF THE SECRETARY, BOSTON, Jan. 15, 1895.

Hon. GEORGE v. L. MEYER, *Speaker, House of Representatives.*

SIR: — I have the honor to transmit herewith, for the use of the Legislature, the fourth annual report of the Dairy Bureau of the Massachusetts Board of Agriculture, required under chapter 412, Acts of 1891.

Very respectfully,

WM. M. OLIN,
Secretary.

DAIRY BUREAU — 1894–1895.

C. L. HARTSHORN, WORCESTER, *Chairman.*
GEO. L. CLEMENCE, SOUTHBRIDGE.
D. A. HORTON, NORTHAMPTON.

Executive Officer.

W. R. SESSIONS, *Secretary of the State Board of Agriculture.*

Assistant and Acting Executive Officer, appointed by the Governor.

GEO. M. WHITAKER, BOSTON.

REPORT OF THE DAIRY BUREAU.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The third year of the existence of the Dairy Bureau has witnessed no change in the membership of the Bureau or its executive officers. The work has continued along the general lines indicated by previous reports, but extended and broadened as a result of increased experience. Additional workers have been employed in both the educational and police departments. But there comes a time when the expansion due merely to the increased effectiveness of greater experience must cease. It costs money to employ lecturers, agents, chemists and others. As we said last year, $4,000 is a very small sum for the duties imposed on us by statute. In the educational field there is need of additional work, particularly at the present time, when the Cattle Commissioners are doing so much to prevent the spread of tuberculosis; their work is only half done if it is not supplemented by the gospel of cleanliness, pure air and plenty of sunlight. In our report for 1892 we said that the keeping qualities of milk depend on cleanliness; but besides this the germs of disease are kept in abeyance by wholesome food, air, sunlight and clean stables. Then in our police work we can keep several agents profitably employed all of the time. We have been unable to give any attention to the enforcement of the milk laws, but could do much in this direction, to the ultimate advantage of the consumer and producer. We renew our suggestion of last year, that the appropriation for the Bureau be increased, with a repeal of the requirement that the Board of Health expend a majority of its funds on dairy products, — with this object in view: that the Bureau should prosecute commercial frauds, while the

Board of Health should be unhampered in its health work. An increased appropriation will not mean necessarily increased burden on the tax payers, because much will be returned in fines. At present nearly half of our appropriation goes back to the public in that way. If we are given more funds for enforcing the dairy laws, there will be more fines. We have expended all our appropriation this year, and yet have seen much which ought to have been done, but which we were obliged to omit. We recommend that the amount be increased to $7,000.

Colored Oleomargarine "an Offence against Society."

The great event of the year has been the decision of the national supreme court that the Massachusetts "anti-color" law "is not repugnant to the commerce clause of the constitution." The court said: —

> It is within the power of a State to exclude from its markets any compound manufactured in another State which has been artificially colored or adulterated so as to cause it to look like an article of food in general use, and the sale of which may, by reason of such coloration or adulteration, cheat the general public into purchasing that which they may not intend to buy. The constitution of the United States does not secure to any one the privilege of defrauding the public. The deception against which the statute of Massachusetts is aimed is an offence against society; and the States are as competent to protect their people against such offences or wrongs as they are to protect them against crimes or wrongs of more serious character. And this protection may be given without violating any right secured by the national constitution and without infringing the authority of the general government. A State enactment forbidding the sale of deceitful imitations of articles of food in general use among the people does not abridge any privilege secured to citizens of the United States, nor, in any just sense, interfere with the freedom of commerce among the several States.
>
> The judiciary of the United States should not strike down a legislative enactment of a State — especially if it has direct connection with the social order, the health and the morals of its people — unless such legislation plainly and palpably violates some right granted or secured by the national constitution, or encroaches upon the authority delegated to the United States for the attainment of objects of national concern.

This case was an appeal from the decision of the Massachusetts supreme court. This Commonwealth was represented before the national supreme court by ex-Attorney-General Hon. A. E. Pillsbury, who made a remarkably able argument, — one which has attracted much attention in other States as well as in Massachusetts. The chances were considered somewhat against his contention, because the court had decided that local laws could not prohibit the sale of intoxicating liquors in the original package as brought from some other State. On this decision the oleomargarine interests expected to defeat our law. Mr. Pillsbury maintained that, as this law prohibited the sale of an *imitation product* rather than a distinct or original article, the cases were not parallel, and that the fundamental law of the land has enough of State rights to allow States to regulate and even prohibit the sale of imitations. The national supreme court took this view of the case. The decision is not only of much importance in this State, but is of inestimable value in many other States; they are thanking Massachusetts for her pioneer work and for the ability of her legal representative. The decision is also of importance in establishing a valuable principle in the interplay of State and national governments. As this decision was not handed down until December 10, it has as yet been of little advantage to us, and there has not been enough time for the oleomargarine interest to decide on a definite policy.

Some seem disposed to accept this decision, and are putting on the market an article so light in color that it is not an imitation of the average of butter, though it is an imitation of very pale butter. Others are inclined to fight the law yet further by quibbling over the expression "pure butter" and its color. They claim that pure butter is butter without any artificial coloring matter, that its natural color is very light; that the natural color of oleomargarine is a bright yellow, and therefore that oleomargarine is not an imitation of pure butter. If this argument of a part of the oleomargarine people is sound, it proves that the light-colored goods of the other part are an imitation of pure butter, and hence illegal. It has been seriously maintained that butter from fancy cows fed unusual and costly foods may be bright yellow, but that such an article is so exceptional and rare that it could not have been meant by the Legislature in alluding to "pure butter."

Other Decisions.

In a case against Charles H. Russell, for exposing for sale an imitation of yellow butter, his defence was that he exposed for sale the oleomargarine in such a manner as to advise all consumers of its real character. The State supreme court says: —

> The proviso that allows the sale of oleomargarine "in such separate and distinct form and in such manner as will advise the consumer of its real character, free from coloration or ingredient that causes it to look like butter," only saves such oleomargarine as is free from coloration or ingredient that causes it to look like butter. The statute did not intend to allow oleomargarine to be made or sold when so colored, whether the particular purchaser was advised of its real character or not.

In a case for delivering oleomargarine made in imitation or semblance of pure butter from a wagon without the proper signs, the defence claimed that there are two kinds of oleomargarine, as recognized by the anti-color law, and that the kind delivered was not in imitation of pure butter. The court decided: —

> This statute was not intended to draw fine distinctions between kinds of oleomargarine which all resemble each other, but it requires that every one who thus delivers oleomargarine of whatever sort shall carry along with him upon his vehicle a public notice that he is licensed to sell oleomargarine, — in other words that he shall go under his true colors.

Enforcement of the Law.

This work has been hampered by the uncertainty during most of the year about the anti-color law; but the other laws have been prosecuted with vigor, as two agents have been at work most of the time collecting evidence. As heretofore, we have done nothing in Boston, that field being so well worked by Dr. Harrington, the city milk inspector, and nothing has been done with the milk laws.

The following is the statistical report of our work: —

Number of inspections,	716
Number of samples taken,	388
Number of cases in court,	104

Of these the results were as follows: —

Guilty,	68
Acquitted,	32
Nolo',	3
Nol. pros.,	1
Total,	104

Of the 32 cases acquitted, 10 were lost by contradictory evidence, 11 on technicalities.

The causes for action were as follows: —

Serving oleomargarine for butter in restaurants,	28
No signs in stores,	21
Selling oleomargarine when butter was called for,	17
Lack of proper signs on tubs,	15
No mark on wrapper,	14
No municipal license,	9
Total,	104

This is twice as much as we have done in any previous year. Our policy has been to secure compliance with the laws with as little distress or seeming persecution as possible; and no objections have been raised to putting cases on file when the judge was satisfied that good reasons therefor existed. Fines aggregating nearly $2,000 have been imposed.

MILK INSPECTORS.

The statutes give town and city milk inspectors concurrent jurisdiction with the Dairy Bureau; but the report of their work is only to the local authority, and hitherto there has been no means of presenting this information to a larger constituency. In many cases these local inspectors get only a nominal salary, and hence do but little aggressive work. We have endeavored to co-operate and work with them to mutual advantage, and we are indebted to many inspectors for much information and assistance. Their work is for the most part confined to the milk laws. The best work is done in Boston, where ample funds warrant the securing of excellent ability. From Dr. Harrington's last published report we extract the following information: —

Number of samples of milk examined,	13,623
Number of samples of butter and oleomargarine,	899

During the year complaints were entered in court as follows: —

For milk not of good standard quality,	142
For milk not of good standard quality (restaurant cases),	125
For skimmed milk not of good standard quality,	3
For adulterating milk with annato, caramel or boracic acid,	23
For violating license law,	18
For sales of oleomargarine not properly marked,	48
For violation of the oleomargarine license law,	17
For oleomargarine wagons not properly marked,	9
For exposing oleomargarine in stores without signs,	5
For sales of oleomargarine as butter,	51
For sales of imitation butter,	3
For serving oleomargarine in restaurants without notice to guests,	109

The Cambridge inspector, Dr. F. A. Dunbar, reports 1,882 samples of milk collected, of which 262 were below standard quality; 179 warnings were sent out; 75 samples of butter were purchased, of which 3 proved to be oleomargarine. The inspector reports that the quality of milk procured from stores and teams is on the whole improving; skimming and watering constitute the usual forms of adulteration.

The Lowell inspector, Thomas O. Allen, reports 1,258 milk inspections, with 26 warnings, and 17 complaints for having in possession, with intent to sell, milk not of good standard quality; convictions, 15.

The Lynn inspector reports 2,236 inspections of milk, with 18 complaints in court, resulting in 17 convictions.

The Holyoke inspector, James K. Morrill, reports 58 inspections of milk and 1 prosecution.

H. M. Hartshorn of Malden reports 136 inspections of milk and 1 prosecution. He recommends a law which should establish a legal standard for light cream to be sold in packages of not less than one gallon, and another for small packages of heavier cream for family use. He reports a continual increase in the cream business.

The Worcester inspector, J. P. Streeter, reports 138 samples of milk taken, of which only 3 were below standard.

In New Bedford Dr. D. C. Ashely took 650 samples of milk, and 1 complaint was made after a warning. Another conviction was for feeding swill.

In Chelsea the milk inspector took 950 samples; issued 30 warnings; 15 cases were taken into court and 9 convicted.

Need of Law.

Another year's experience convinces us more than ever of the need of laws to regulate the sale of imitation butter, and we renew the suggestions of previous reports. The word "imitation" conveys the idea of deceit and imposition, and the actual business comes as close as is possible to the line between honesty and dishonesty when it does not actually cross over. The temptation to deceive is strong and always present. "Butterine," the name now coming to be generally used (although the national law uses the word "oleomargarine"), is significant of deception. The gradual abandonment of the word "oleomargarine" and the substitution therefor of "butterine" speaks volumes for the nature of the business. In England the use of the word "butterine" is prohibited by law, and we recommend it here. In one large English city the Board of Trade condemned the use of such affixes as "ette" and "ine" for textile fabrics, because of their deceptive nature. For the purpose of uniformity in existing laws, and to prevent the raising of any question growing out of an apparent lack of harmony, we recommend that section 21 of chapter 56 of the Public Statutes be declared applicable to all subsequent legislation.

Educational.

The assistant executive officer has spoken at public meetings 37 times, — chiefly upon milk, its composition, variation, keeping qualities and kindred topics. When the importance of the meeting would warrant, additional speakers have been employed. Professor Conn of Connecticut, one of the most advanced bacteriologists of the age, came to Massachusetts under the auspices of the Bureau, to explain to a meeting of butter makers his experiments and conclusions. Experiments have been tried at the West Dudley creamery with some of his culture, at the suggestion of the Bureau.

Babcock Milk Tester.

Work in illustrating the importance of the Babcock milk tester has continued. Much effort has been expended in impressing the fact that milk should be valued by the amount of solid matter that it contains, — the Babcock tester furnishing an accurate, cheap and simple means of ascertaining this information. As a result of this influence, several agricultural societies have based their milch-cow premiums in a measure on the quality of the cow's product. During the year the acting executive officer has tested 448 samples; 5 more have been referred to a chemist for fuller examination. Most of these tests were made publicly, as object lessons in the course of addresses on the character of milk.

Some of these samples were taken for the purpose of studying abnormal conditions. For instance, a sample from a sick heifer from a fine butter family tested as low as 1.8 per cent. of fat. The milk from the top of a can tested 8.2 per cent. of fat, while that from the bottom of the same can tested only 2 per cent. Milk from strippings and the last of milkings ranged from 7 to 12 per cent. The following is the result of the ordinary samples: —

2.6 and 3.0 per cent. of fat,	1 per cent. of samples.
3.2 and 3.4 per cent. of fat,	8 per cent. of samples.
[Below the legal standard, 9 per cent. of samples.]	
3.6 and 3.8 per cent. of fat, on the line of the legal standard,	20 per cent. of samples.
4.0 and 4.2 per cent. of fat,	18 per cent. of samples.
4.4 and 4.6 per cent. of fat,	13 per cent. of samples.
4.8 and 5.0 per cent. of fat,	13 per cent. of samples.
5.2 and 5.4 per cent. of fat,	14 per cent. of samples.
5.6 and 5.8 per cent. of fat,	7 per cent. of samples.

5.8 and 6.0 per cent. of fat,	3 per cent. of samples.
6.1 and 6.2 per cent. of fat,	3 per cent. of samples.
6.4 and 6.8 per cent. of fat,	2 per cent. of samples.

[Above the standard, 73 per cent. of samples.]

Samples of cream tested have ranged from 14.6 per cent. to 20 per cent. of fat. The buttermilk tested averaged .3 per cent. of fat, and the skimmed milk ranged between .8 and .6 per cent.

In one instance a visit was made to a farm whose proprietor was having trouble with the Boston milk contractors because the milk produced by him was below the standard. Each cow in the herd was tested, with the following result: —

No. 1,	2.4 per cent.
No. 2,	2.6 "
No. 3,	2.8 "
No. 4,	2.8 "
No. 5,	3.0 "
No. 6,	3.0 "
No. 7,	3.2 per cent.
No. 8,	3.3 "
No. 9,	3.6 "
No. 10,	3.8 "
No. 11,	4.0 "
No. 12,	4.0 "

The average of the mixed milk of the herd was 3.1 per cent.

The Bay State Agricultural Society in June offered a prize for the milch cows which would produce the greatest amount of milk solids in two days. The testing was to be done at home, free from the distracting influences of the average cattle show. This was a decidedly advance step in agriculture, and one in keeping with the aims of the Bay State Society. The Massachusetts Society for Promoting Agriculture offered to help out on the expense of the premiums, and the assistant executive officer of the Dairy Bureau offered to do the work of testing the milk. This novel and educational offer did not attract as much attention as its merits deserved, and it was hard work to secure five entries; only one was ready for examination during the summer and fall before the executive officer's increasing duties of the early winter precluded the attention to this extra work. The Guernsey herd of Herbert Merriam, Esq., of Weston, was tested, with the following result: —

	Pounds Milk.	Per Cent. Solids.	Pounds Fat.	Pounds Total Solids.
Polly of Concord,	32.81	15.50	1.82	5.09
Golden Lily,	37.75	15.03	1.97	5.68
Polly of Lincoln,	37.06	15.32	2.00	5.69
Rose of Weston,	40.64	14.95	2.06	6.06
Weston Lily,	43.50	14.75	2.15	6.40
Average,	-	15.11	-	5.78
Total,	191.76	-	10.00	-

THE MILK SUPPLY

of the cities of the Commonwealth is one of the most important branches of the food question, both commercially and hygienically. The milk contractors of Boston, whose business includes the "greater Boston," and is estimated at three-quarters of the entire supply, report the business of 1894 in eight and one-half quart cans as follows: —

	Received.	Sold.	Surplus.
January,	768,883	617,674	151,209
February,	719,864	564,148	155,716
March,	842,882	642,637	200,245
April,	861,458	622,907	238,551
May,	969,331	661,223	308,108
June,	937,188	696,578	240,610
July,	837,425	699,692	137,733
August,	779,766	617,220	162,546
September,	716,771	634,269	82,502
October,	779,015	637,329	141,686
November,	722,316	634,792	87,524
December,	770,548	628,952	141,596

TOTALS.

	Received.	Sold.	Surplus.
1891, ...	7,281,524	6,113,803	–
1892, ...	9,212,667	7,315,135	–
1893, ...	9,263,487	7,619,722	1,643,765
1894, ...	9,705,447	7,657,421	2,048,026

The following figures for other cities are taken from milk inspectors' reports: —

Springfield, 19,000 quarts daily, mostly furnished by three adjoining towns.

Chelsea, 10,664 quarts daily.

Malden, 11,000 quarts daily.

Holyoke, 15,387 quarts daily.

Lynn, 24,000 quarts daily, one-half coming from Portsmouth and Hampton, N. H., in cars, and one-half from dairies of adjacent towns.

MILK STANDARD.

An effort has been made each winter for several years to have the statute standard of milk reduced. Unquestionably many cows in the State produce milk that is below the standard. But it is also a fact that the milk of a great majority from all breeds contains 13 per cent. of solids, — the legal standard. The practical question is, Shall the interests of the majority be sacrificed for the minority? The present law is not perfect; under an ideal condition, all milk would be sold according to its quality; but that is impracticable at present, although we believe that ultimately, with the Babcock test more common and the people more enlightened as to milk values, this result will be reached. But this is not the real point desired by the advocates of the change as we understand it. They desire to get their 12 per cent. milk on the market at the going price, — that is, the price for the 13 per cent. milk.

One point against the present law that is used with much force is the claim that the standard hangs like a sword of Damocles above the head of the innocent farmer, liable at any moment to descend upon him without either warning or mercy. Facts do not bear this out, however, as reference to the reports of the milk inspectors above will show. Not only do reports of many thousands of analyses from all parts of the country show that average milk contains 13 per cent. of solids, but the results of inspections reported above show that even after the milk has gone to the peddler and the stores ninety-nine samples in a hundred stand the test. Mr. Clemence of the Bureau has been studying the question on his own herd, and gives below the result of five tests of the mixed milk of his cows — grade stock of no particular breed.

DATE.	Cows.	Quarts Milk.	Daily Feed.	Per Cent. of Fat.
Aug. 1,	20	208	Green oats and peas morning and night, dry hay at noon, 2 quarts gluten meal and 4 quarts bran.	4.4
Sept. 1,	21	212	Sweet corn fodder morning and night, hay at noon, grain the same as above.	4.2
Oct. 1,	21	188	Corn fodder and cabbage leaves morning and night, hay at noon, with grain same as above.	4.2
Nov. 1,	20	205	Cabbage leaves in two feeds, hay at noon, with grain same as above.	4.3
Dec. 1,	20	192	Corn ensilage morning and night (forty pounds a day to each cow), six pounds of hay at noon, and grain the same as above.	4.2

When milk has 3.75 per cent. of fat it is without much doubt up to the standard, so that this milk, if a complete analysis were made, would probably test from 13.50 to 14 per cent. solids.

Financial Statement.

Appropriation by Legislature of 1894,	$4,000	
C. L. Hartshorn, Chairman : —		
Travelling and necessary expenses,		$44 00
Services,		60 00

G. L. Clemence: —	
Travelling and necessary expenses,	$62 50
Services,	65 00
D. A. Horton: —	
Travelling and necessary expenses,	63 00
Services,	60 00
G. M. Whitaker, assistant executive officer, travelling and necessary expenses,	268 18
Agents, services and expenses,	1,870 76
Chemical work,	1,083 50
Court attendance,	115 00
Educational work,	195 27
Printing,	57 76
Supplies,	55 03
	$4,000 00

Respectfully submitted,

GEO. M. WHITAKER,
Assistant and Acting Executive Officer.

Approved and adopted as the report of the Dairy Bureau.

C. L. HARTSHORN.
GEO. L. CLEMENCE.
DWIGHT A. HORTON.

BOSTON, Jan. 15, 1895.

REPORT

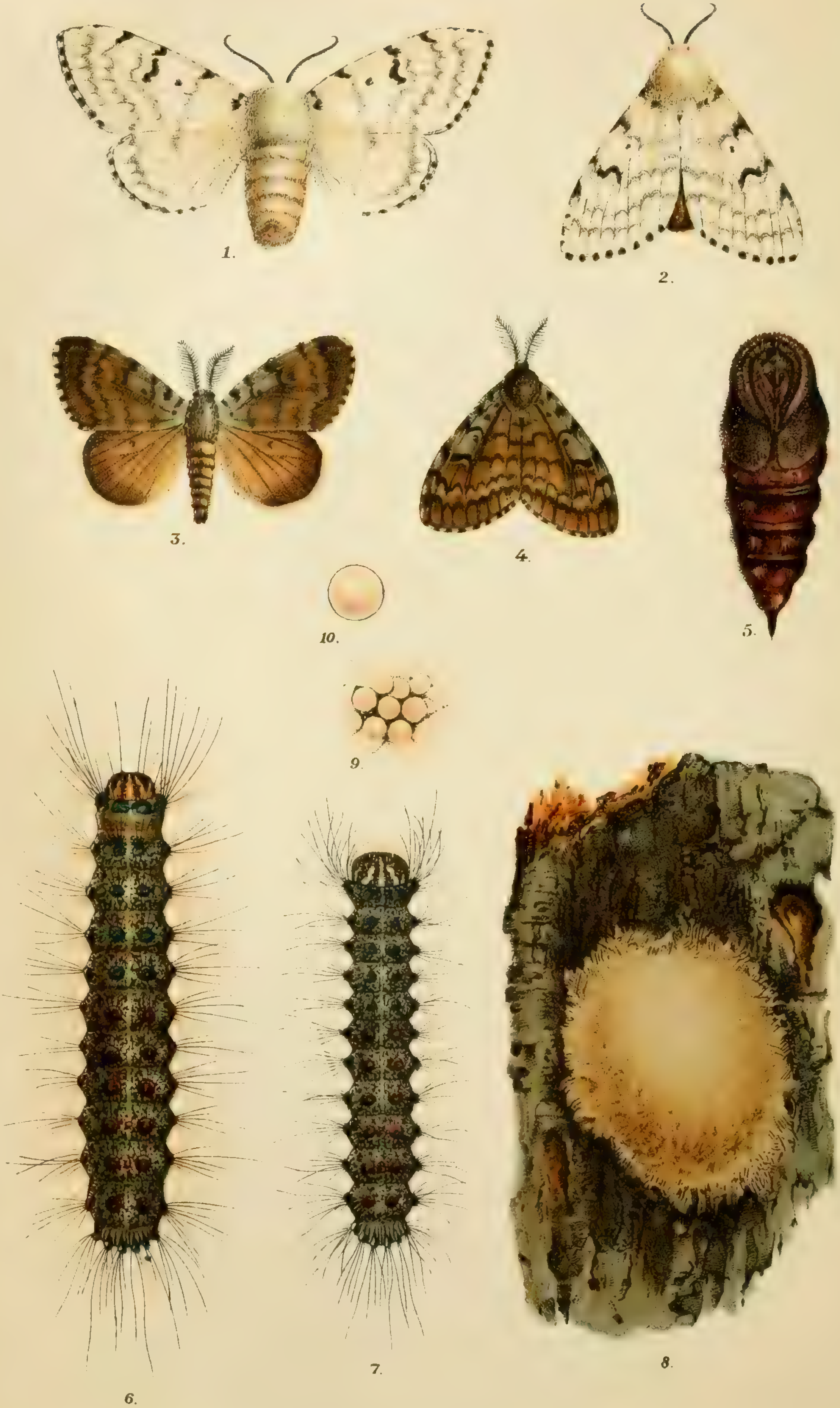
OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE GYPSY MOTH.

PLATE I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Drawn by Joseph Bridgham.

Geo. H. Walker & Co., Boston.

GYPSY MOTH.

EXPLANATION OF PLATE I.

GYPSY MOTH (Ocneria dispar, L.)

Fig. 1. — Female with the wings spread.
2. — Female with the wings folded.
3. — Male with the wings spread.
4. — Male with the wings folded.
5. — Pupa.
6. — Caterpillar. } Full grown.
7. — Caterpillar. }
8. — Cluster of eggs on bark.
9. — Several eggs enlarged.
10. — One egg greatly enlarged.

Figures 1 to 8, inclusive, natural size.

Commonwealth of Massachusetts.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

I have the honor to present herewith to the General Court the report of the committee of the State Board of Agriculture in charge of the gypsy moth work to said Board, and the reports of the director of field work and the entomologist to said committee, as the report of the State Board of Agriculture on the extermination of the gypsy moth; the statement of receipts and expenditures and the recommendations and suggestions contained in said reports being adopted by said Board and presented in accordance with the provisions of chapter 210, Acts of 1891, as their recommendations and suggestions.

WM. R. SESSIONS,
Secretary of the State Board of Agriculture.

BOSTON, Jan. 9, 1895.

Commonwealth of Massachusetts.

To the Massachusetts State Board of Agriculture.

In accordance with the provisions of law, the committee on the gypsy moth, insects and birds of the State Board of Agriculture presents the report of expenditures and work performed in the endeavor "to prevent the spreading and secure the extermination of the *Ocneria dispar*, or gypsy moth, in this Commonwealth."

Early in the year Prof. N. S. Shaler, who had been most prominent in the work of the committee from its beginning, resigned from the Board of Agriculture on account of pressure of other duties, and the committee was thereby deprived of his very valuable assistance. Mr. Francis H. Appleton, who had also been from the first a member of the committee, resigned from the committee, soon after the decision of the Legislature not to appropriate the sum asked for the year 1894 by the Board, his reason for resigning being that the sum appropriated was insufficient to do what the law required the committee to do. Thus the committee has been deprived of the assistance of two members of largest experience. The committee is happy to be able to state that both these gentlemen were in perfect accord with the other members, and that from the first all plans were made and carried out with the unanimous approval of all the members.

On May 1, the appropriation of 1893 having been expended, all field work was discontinued. The appropriation for 1894 did not become available until May 23 and thus nearly two weeks of the most valuable working time of the season were lost. The indirect losses and delays were quite as important as the loss of working time of the men laid off.

The work has suffered in the past three years almost as much by delay of appropriations as by refusal to appropriate the sum asked for by the committee.

The region which was found to be infested in 1891 by the gypsy moth was something over two hundred square miles in extent. It included thirty townships and considerable portions of three counties. It was learned in 1891 that the moth had been distributed for several years over this region, though it had not become abundant enough to be considered a pest except in a few of the central towns. The present condition of this region as regards the relative abundance of the gypsy moth in the various sections is as follows: —

In ten of the outer towns the moth has been apparently exterminated; in five more it has been very nearly exterminated. More than a thousand well-marked moth colonies have been stamped out of existence. In all of the infested towns such sections as have been worked over year after year by the employees of the State Board of Agriculture are now nearly cleared of the moth, and the general condition of the inhabited and cultivated lands is better than ever before. Against this favorable condition of such portions of these towns we must place the fact which has been revealed by the inspection of the past season, — that the woodlands in many of the towns are much more generally infested than has been hitherto supposed. Scattered colonies of the moth are now known in the woods of Lexington, Winchester, Arlington, Belmont, Stoneham, Medford, Wakefield, Melrose, Malden, Lynnfield, Saugus, Revere, Swampscott, Lynn and Salem.

This condition of the forested lands is due to the fact that there has not been money enough to provide for destruction of these colonies whenever found. It has been impossible, with the means at our command, to make a thorough search of all this woodland; but during the past season special efforts have been made to inspect it so far as was possible under the circumstances, and enough is now known to justify the presumption that colonies of the moth are scattered through the woods from Lexington to the sea. Though many of the colonies found have apparently had their origin within two or three years, many others originated at least ten years since. The woodland which is thus more or less infested probably covers fifty square miles of the central and north-central portions of the infested district.

In the attempt to exterminate the gypsy moth it was early ascertained that the species was spread over a region many times greater than that which was at first known to be infested, and that it was not confined to lands under cultivation, but had penetrated to some extent into the woodlands. These discoveries made it certain that extermination would be extremely difficult, requiring years for accomplishment even under the most favorable conditions. The best methods known and used at first were not effectual in securing extermination, and the methods which later proved effective were so expensive that they could not be carried out over so large an area without larger appropriations than those which have been granted.

Although the extent of the infested region, the existence of the moth in woods and the great expense of exterminative methods have been all repeatedly presented to the Legislature in the annual reports of this Board, the amount appropriated for each of the past two years has been only about two-thirds of that recommended by the Board as absolutely necessary to do all that could be done to advantage under the circumstances.

The law requires the Board "to use all reasonable measures to prevent the spreading and to secure the extermination" of the moth. The Board has apparently been successful in preventing the spread of the moth and has considerably lessened the area known to be infested. It has never had an appropriation sufficiently large to do all that might have been done in one year toward the extermination of the moth. If the work is to be carried on under the present statute and the policy of extermination is to be continued, we believe that two hundred thousand dollars should be appropriated for the work of the coming year.

The committee believes that the work of extermination should be continued, but is also firmly of the opinion that, if the Legislature is unwilling to appropriate the sum necessary for an aggressive campaign for extermination, the law should be changed so that the Board of Agriculture shall be required to conduct the work only along the line of preventing the spread of the gypsy moth. The committee further believes that, if the Legislature is unwilling to provide sufficient funds for restricting the spread of the gypsy moth and holding it in check, the work should be discontinued entirely. The committee is not in favor of appropriating inadequate funds for the work in hand. It seems unjust to require the extermination of the pest while providing inadequate means for the purpose. The Board of Agriculture has recommended for each of the past two years an appropriation of one hundred and sixty-five thousand dollars, believing that sum was absolutely required for the successful prosecution of the work. The Legislature has appropriated only one hundred thousand dollars, or about sixty per cent of the sum asked for each of these years.

In order to have the opinions of experts on the work as carried on by the committee, and on the prospect for the future, several entomologists from other States were invited in 1893 to inspect the work and report to the committee. Their opinions were given in the last annual report to the Legislature. In June last Dr. Geo. H. Perkins of the University of Vermont, entomologist of the Vermont State agricultural experiment station, and Prof. F. L. Harvey, botanist and entomologist of the experiment station at the Maine State College, were invited to visit the infested region and inspect the work and report upon it to the committee. Later, Prof. J. Henry Comstock of Cornell University, Ithaca, N. Y., formerly United States entomologist, and Mr. L. O. Howard, entomologist of the United States Department of Agriculture, were also invited and examined the region and inspected the work. Professor Comstock made a report to the committee, and Mr. Howard, later in his annual address before the sixth annual meeting of the Association of Economic Entomologists, of which he is president, gave his impressions and opinions of the work. These gentlemen all gave the committee the benefit of their criticism and advice. Their opinions varied; but, that the Legislature may have the benefit of them, the reports of the first three mentioned and so much of the address of Mr.

Howard as refers to this work are printed in the Appendix to this report.

The committee has had the advice of Prof. C. H. Fernald, entomologist of the State Board of Agriculture and of the committee throughout the year, and the experimental work has been under his immediate direction and supervision. The field work has been managed by Director E. H. Forbush, who has had charge of it since the Board of Agriculture assumed the direction by act of the Legislature in 1891. A report upon the scientific facts ascertained and the history of the gypsy moth in Europe and America is being prepared under authority of the resolve which provided for the continuance of the work in 1894; and the committee recommends that an appropriation be made for printing the same, as it will be a work of great interest and value to the public at large, as well as to entomologists.

In view of the fact that a large appropriation is recommended if the intent and purpose of the statute are to be carried out, it is proper to inquire whether extermination is possible under the present known conditions. It has been fully proved that the moth can be exterminated, not only from limited localities, but from considerable areas. If ample appropriations can be secured and the methods which have proved successful in these instances can be carried out over the whole region for a few years, it is quite evident that the moth (providing it is confined to the region known to be infested) can be exterminated.

In order to secure extermination, each colony must first be found by a careful inspection of the entire region which is known to have been infested, — a region over two hundred square miles in extent. In order to guard against the spread of the moth and to give positive evidence that the limits of its dissemination have been found, we must examine surrounding towns covering at least two hundred square miles more. Each colony found in the egg-form must first be cleared of eggs by carefully searching for and destroying all that can be found. The infested trees must have the loose bark removed by scraping, all dead limbs must be cut, the cavities filled, the undergrowth cut and burned and even the dead leaves on the ground destroyed. In order to determine positively whether the eggs have been all destroyed, the trees must be then banded as usual with burlap and watched to make sure that any larvæ appearing beneath the bands may be killed and their escape thereby prevented. It will then be necessary to watch the place and its vicinity for two or three years to be absolutely certain that no trace of the insect is left, or that the locality does not become reinfested from some such cause as originally infested it. All this work is expensive.

On Jan. 1, 1894, there remained unexpended $29,744.69 of the appropriation of 1893. This was retained in order that the work might be continued until the Legislature could make provisions for the work of the present year. This has been expended together with $79,464.58 of the present appropriation, making $109,209.27 expended between Jan. 1 and Dec. 31, 1894. Having estimated the probable expense which must be incurred to do all that is possible toward extermination for the coming year, we have apportioned it as follows: —

Wages for one hundred and twenty-five experienced, competent men for one year (three hundred days), at an average of $2.25 per day, ...	$84,375
Wages of three hundred men for temporary employment during five months of spring and summer, at an average of $2 per day, ...	78,600
Wages of sixty-five men (selected from the preceding class) for the last four months of the year, ...	14,534

making the amount to be paid in wages to superintendents, inspectors and men, $177,509. We must add to this the salaries of director, entomologist and clerks; the travelling expenses of the committee, entomologists, director and men; the teaming and care of horses; the expenses of experimental work; rent, supplies, tools, insecticides and incidentals, — an estimated expense of $23,336, making altogether $200,845, the detailed estimate of expenses for the year 1895.

The reports of Prof. C. H. Fernald, entomologist to the committee, and of Edward H. Forbush, director of the field work, are presented herewith as a part of the report, and the committee refers to these reports for details of the work.

The following is the financial report for 1894 of the gypsy moth department of the State Board of Agriculture: —

Balance on hand Jan. 1, 1894,	$29,744 69
Appropriation for 1894,	100,000 00
	$129,744 69

EXPENDITURES.

Wm. R. Sessions, expenses,	$22 50	
Augustus Pratt, expenses,	56 16	
Francis H. Appleton, expenses,	3 99	
E. W. Wood, expenses,	16 75	
C. H. Fernald, expenses and remuneration,	686 13	
E. H. Forbush, director, salary,	2,400 00	
Book-keeper and clerks in office,	2,273 62	
Travelling expenses of director and men,	1,719 30	
Teaming, livery and board of horses,	2,754 54	
Wages of men,	89,161 39	
Rent of storehouses and office,	366 00	
Supplies, tools and insecticides,	9,748 89	
Balance on hand Jan. 1, 1895,	20,535 42	
		$129,744 69

Since the above report was completed, the Board of Agriculture received notice from the agricultural committee of the United States Senate that it would give a hearing on Friday, Jan. 4, 1895, upon the resolve of the last Massachusetts Legislature, adopted by the House of Representatives May 17, 1894, and by the Senate May 21, 1894, requesting "the Senators and Representatives from this Commonwealth in the Congress of the United States to urge upon Congress the necessity of prompt and vigorous action to exterminate said pest (gypsy moth), and to use their influence to secure from Congress an appropriation of one hundred thousand dollars to assist this Commonwealth in defraying the necessary expenses of the work."

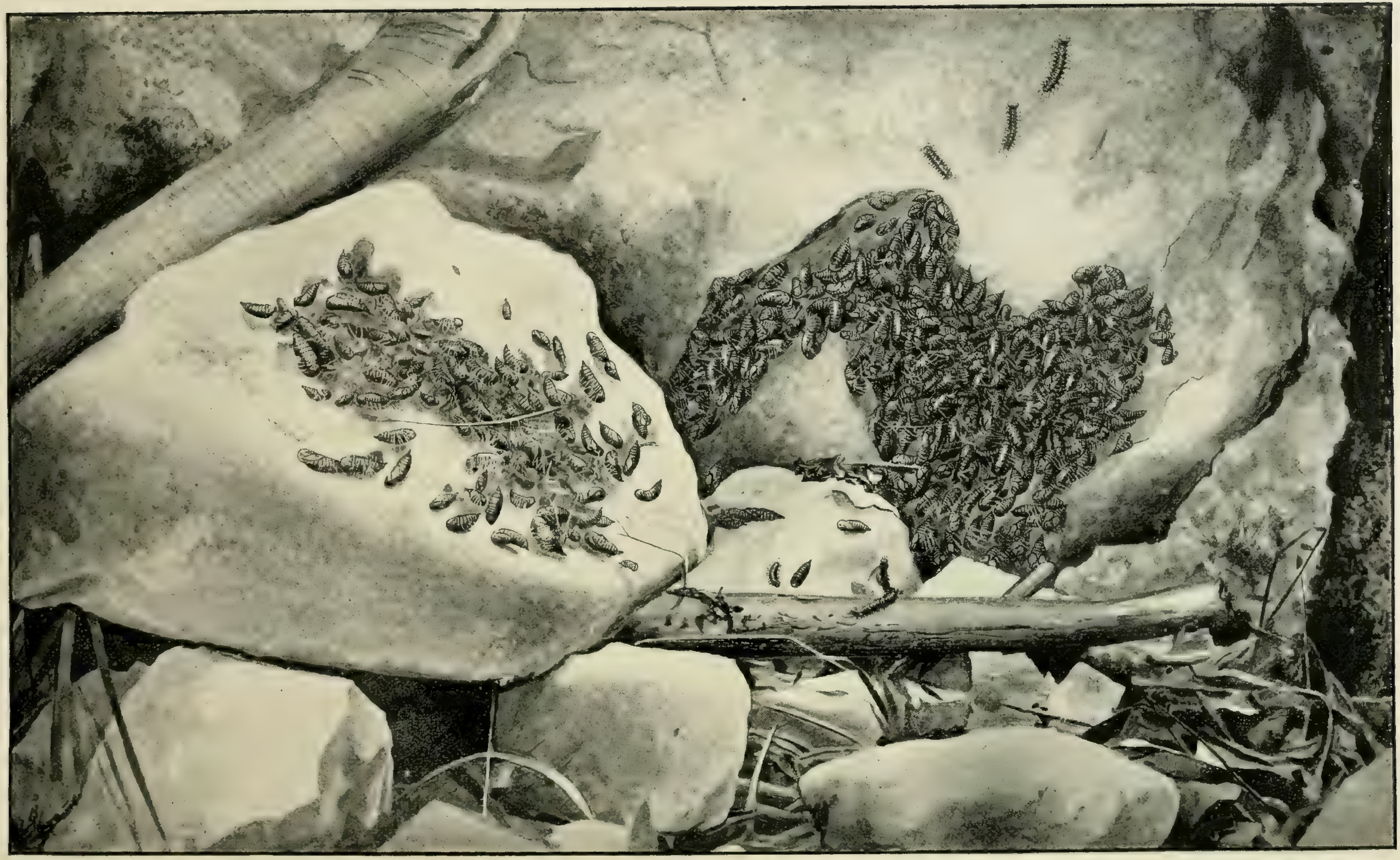
A committee of the Board of Agriculture, consisting of Francis H. Appleton and Wm. R. Sessions, with Director of Field Work E. H. Forbush as expert, appeared before said committee and also before the committee on agriculture of the United States House of Representatives, on January 5, at a special hearing upon a resolution introduced into Congress by Hon. William Cogswell, which provided for an appropriation of one hundred thousand dollars for the purpose asked for by the resolution of the Massachusetts Legislature. The committee also presented the matter to Hon. J. Sterling Morton, United States secretary of agriculture.

In each case the committee of the Board of Agriculture was heard with great apparent interest and was treated with great courtesy.

E. W. WOOD,
WM. H. BOWKER,
AUGUSTUS PRATT,
F. W. SARGENT,
WM. R. SESSIONS,

Committee of the Board of Agriculture, in Charge of the Gypsy Moth Work.

PLATE 2.



GYPSY MOTH PUPÆ.

A stone has been rolled away from a ledge, exposing the mass of pupæ.

(From a photograph taken at Arlington, Mass., July 9, 1891.)

FIELD DIRECTOR'S REPORT.

To the Committee on the Gypsy Moth, Insects and Birds.

GENTLEMEN: — By retaining a portion of the appropriation of 1893, the committee was enabled to keep some of the most competent men employed through most of the winter. These served as a nucleus for a summer force. There were eighty-three men at work on Jan. 1, 1894. Much of the weather during the month was mild, and therefore favorable for the search for and destruction of eggs. On bright winter days, when the temperature is not too low, the leafless deciduous trees can be inspected to the best advantage. Thousands of egg-clusters were gathered during the month, the small amount of snow making possible the examination of woods as well as open and cultivated lands. In cold and stormy weather the men cut and burned infested brush and trees in Saugus, Swampscott, Arlington, Medford, Somerville, Stoneham and Winchester.

During the month of February the work of cleaning up infested places in the outer towns and cutting and burning worthless infested trees and brush was continued without intermission, except when the snow was so deep upon the ground as to render such work impracticable. On February 13 a heavy snow-storm caused most of the work in the field to be suspended for a time. Later in February the men were employed again, and the weather being more favorable, much necessary work was done in the way of inspecting, scraping trees and otherwise preparing for the summer work infested localities in the outer towns.

On March 6 the committee held a joint meeting with the Metropolitan Park Commission, which had recently taken for a public forest reservation most of the Middlesex Fells, situated in Malden, Medford, Melrose, Stoneham and Winchester. Arrangements were made which would enable the agents of the Board of Agriculture to do such work as might be necessary in the Fells without conflicting with the plans of the Park Commission.

Early in March, the weather being favorable, the force of men engaged in field work was increased. Inspecting and egg-killing were carried on whenever the weather permitted until the first of May, when, the appropriation being nearly exhausted, the entire field force was discharged. This enforced suspension of the work was most unfortunate, occurring as it did when the men were destroying the egg-clusters at the rate of thousands per day. Before work was resumed the remaining eggs had hatched and the larvæ had scattered. Had the work not been thus interrupted, it would have been possible in many places to destroy these young larvæ *en masse* by means of burning.

Later in May the Legislature passed a bill appropriating $100,000 for the work. Field work was immediately resumed, and one hundred men were engaged in burlapping trees. The delay in making the appropriation had so hindered the work of the spring and shortened the time for inspection that only a small proportion of the towns in the infested region had been inspected and cleared of eggs before hatching time. As a consequence the men were obliged to search for the caterpillars, — a much more expensive method of checking the increase of the pest than egg-killing. The delay in examining and employing men for the field work, which was rendered inevitable by the lateness of the appropriation, also greatly retarded the work of the summer.

Spraying.

During the experimental work of 1893 arsenate of lead was first used as an insecticide by our chemist, Mr. F. C. Moulton. The results of experiments on the gypsy moth with this insecticide, which were made by Professor Fernald and his assistants, were so successful that it was used in the field on a limited scale during the spring of 1894.

Spraying was begun early in May. Although arsenate of lead when used in great strength has proved the most effective insecticide yet used on the gypsy moth, it was soon determined that it could not be depended upon to exterminate. Though, like other insecticides, it proved effectual in destroying other insects, it did not kill all gypsy moth caterpillars on trees that had been sprayed with the poison of a strength of fifteen pounds to one hundred and fifty gallons of water. It is recorded that where forty pounds were used to one hundred and fifty gallons of water the caterpillars all disappeared. In this case they were presumably destroyed by the poison, although some may have been driven away by the excess of poison on the foliage. In any case such an amount of the poison would be very expensive, and could not be used without incurring some risk of poisoning domestic animals or fowls. Its general use at such a strength is therefore out of the question. Arsenate of lead has two advantages as an insecticide: it can be applied at any desired strength without injuring foliage, and a strong mixture containing glucose will withstand showers and remain on the foliage through an entire season. Thus, although the application of a strong mixture of arsenate of lead is more expensive than that of London purple or Paris green, it may be safer and more economical in the end. For the gypsy moth ten to fifteen pounds to one hundred and fifty gallons of water must be used to have much effect. Its action is slower than that of Paris green, and it should therefore be used early in the season, and of a strength sufficient to check the ravages of the insect as soon as possible.

Although this is the most effective poison yet used on the gypsy moth caterpillars, doubtless it would have failed, like Paris green, to check their ravages when they were in full force. After four years of experimenting I am constrained to believe that no form of arsenic, unless used in unsafe quantities, can be relied upon to hold the gypsy moth in check, much less to exterminate it. The effect of other poisons on the moth has been and is still being investigated, and the results will eventually be made public.

Summer Work.

The killing of caterpillars under the "burlaps," which was begun in June, was continued throughout July and most of August. One hundred seventeen thousand five hundred seventy-four yards, or about twenty-eight tons (56,864½ pounds), of burlap were used in 1894, which was nearly double the amount used in 1893. A large number of traps was prepared for trapping the male moths, with a view of determining whether this would greatly lessen the number of fertile egg-clusters in a region. An experiment of this kind on a small scale had been tried in 1893, with such success that it was decided to experiment on a larger scale, to see if practical results could be obtained in the field. The end sought was the destruction of the male moths, so that the fertilization of the females might be prevented. The experiments conducted the past season were not as a whole successful enough in this respect to warrant the adoption of the method in future work.

The great number of burlapped trees (624,673) to be examined had made it necessary to hire for the summer a large number of men new to the work. Such men can be employed in the examination of burlaps, as this requires faithful service rather than skill or experience. At the close of the burlapping season it was necessary to reduce the force by the discharge of the less experienced and less skilful men. Those men were retained for the fall inspection who, by reason of their experience or ability, were fitted for the work of discovering and destroying eggs and thereby exterminating colonies of the moth. On August 25, at the end of the burlap season, the first reduction of the force was made, and thirty-three men were discharged. Work was also suspended for two weeks, so that the fall inspection and the work of egg-killing might be deferred until the last of the moths had deposited their eggs and had died, when a thorough examination would be most effective.

A Study of the Distribution of the Moth.

Throughout the season all information possible was secured in regard to the distribution of the gypsy moth and the means of its diffusion. Previous investigations had shown that, as the female moth does not fly, the spread of the insect had been due chiefly to the transportation of caterpillars on vehicles. During 1889 and other years when the moth was in great abundance, the young caterpillars which hung down in numbers by their silken threads from badly infested wayside trees frequently dropped upon wagons or carriages and were carried away. Sometimes one or more of them remained upon the vehicle until it arrived at its place of destination. The chances were not great that a colony of moths would result from a single transportation of two or three caterpillars. But the vast amount of regular traffic of all kinds passing in and out or through the badly infested region made possible various transportations of caterpillars to particular localities. The wagon of a market gardener or milkman or swill taker, going daily or weekly to or through a badly infested spot, would be likely, sooner or later, to carry back to its starting-point enough caterpillars to form the beginning of a new colony. Many instances of this sort have been noted. The study of traffic and travel has not only explained for the most part the present distribution of the moth, but also why in twenty years' time it spread such a comparatively short distance, north, south, east and west, from Medford. This slow spread is explained by the fact that the great bulk of the regular traffic and pleasure driving in and out of the badly infested district comes from or goes to closely adjacent territory.

In the investigation of traffic and travel, inquiries were made of teamsters and movers, nurserymen, swill takers, marketmen, farmers, wood dealers, stable keepers, station agents and others having a knowledge of traffic and driving. This work was supplementary to that undertaken in former years, and many of the facts obtained were used later during a search in certain towns outside of the infested district. Owing to the delay in making the appropriation of 1894, this work of outside inspection was not undertaken until autumn, although three men were sent out along the railroad lines to the north and east, to examine points to which shipments of goods had been sent in former years from infested localities. No trace of the moth was found in this inspection.

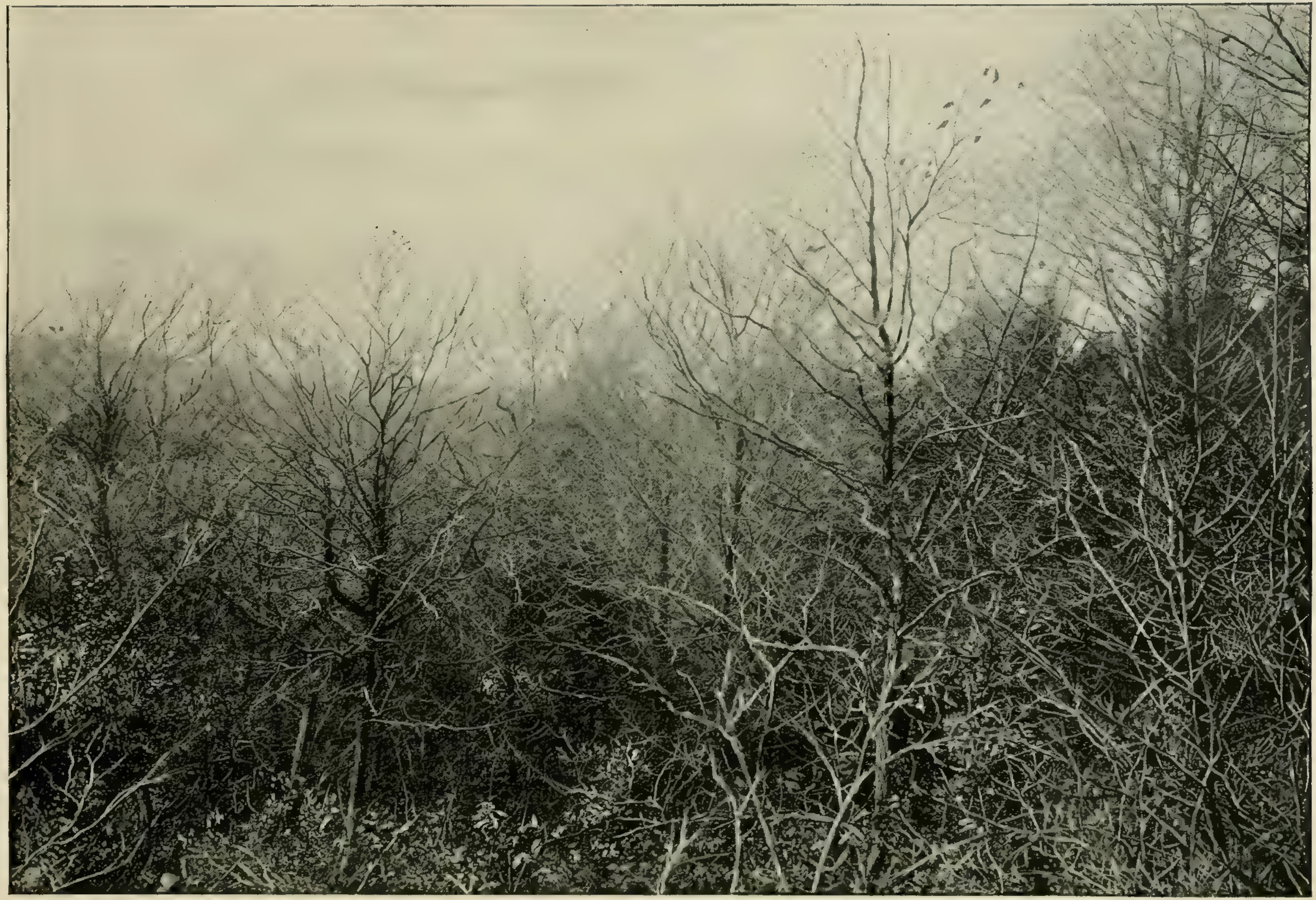
The Fall Inspection.

The appropriation having been greatly reduced, more men were discharged in September, and the field force was finally reduced to one hundred and thirty-three men. In the second week in September the fall inspection was begun. This was confined at first mostly to known infested localities. The inspection of the outer towns could not be made to advantage until late in October, as the leaves remained upon the trees to an unusually late date. After this work had been continued for about ten days it was checked by a snow-storm, which for nearly two weeks made thorough inspection impossible.

While studying the distribution of the moth, it was seen that those centres of population nearest the infested district were most likely to become infested by reason of their frequent communication with towns within that district. It was also learned that there was some traffic, both regular and irregular, with the cities to the north. Lowell, Lawrence, Haverhill and Gloucester, being nearest to the infested region on the north and east, were considered to have been more exposed to infection than cities at a greater distance. Gloucester had been examined in previous years, and no gypsy moths had been found there. As Lowell, from the known circumstances, seemed to have been the place in greatest danger of infection, an examination of that city was made during the last part of October and the first weeks of November. An inspection was also made of points in towns surrounding Lowell, to which traffic from the infested region had been directed; but no moths were found in either the city or its surrounding towns.

Nearly all traffic to the south from the infested region tends toward Boston. The city proper and those suburban portions lying nearest the infested region had been inspected in former years, and no moths had been found except in Charlestown and East Boston. But in 1893, during a partial inspection of the southern district of the city, a colony of moths was found in Franklin Park. Investigation revealed circumstances indicating that the moths had been carried there by pleasure driving several years previous, and soon after the park was opened to the public. This led to the conclusion that the region lying between Franklin Park and the infested towns had been exposed because of the carriage of caterpillars through it. It was then decided to examine that

PLATE 3.



Woodland which was twice sprayed with Paris green and then stripped by the gypsy moth.

(From a photograph taken in Swampscott, Mass., August, 1891.)

region at the earliest opportunity. This examination could not be made in the spring, on account of the lateness of the appropriation; it could not be undertaken in the summer, because of the press of other work; but in the autumn, soon after the leaves had fallen from deciduous trees, an inspection of Boston and its suburbs was begun. A few caterpillars had been found during the summer in one locality in South Boston, and this colony had been stamped out during the season. The inspection of Boston was begun in November, and, though often interrupted by snow, it was pushed during suitable weather, until the city proper, East and South Boston and the Roxbury and Dorchester districts had been examined. The severe storm of December 27, which left the ground covered with snow and ice, put an end to the work of inspection for the year. No more moths were found in South or East Boston, but one colony was discovered in the Roxbury district, between Franklin Park and the city proper, and one colony at the South End in the city proper. Two egg-clusters were also found at one locality in Dorchester.

Enemies of the Gypsy Moth.

From our present knowledge it would seem that several species of native birds are most persistent and effective destroyers of the gypsy moth, and that certain predaceous insects are next in order of usefulness as assistants in the work of extermination. The names of several insects which have not been published heretofore as enemies of the gypsy moth are given in the report of the entomologist, which follows this report.

The following birds have been seen to feed upon the moths, caterpillars or eggs: —

Yellow-billed cuckoo,	*Coccyzus americanus.*
Black-billed cuckoo,	*Coccyzus erythrophthalmus.*
Kingbird,	*Tyrannus tyrannus.*
Phœbe,	*Sayornis phœbe.*
Wood pewee,	*Contopus virens.*
Least flycatcher,	*Empidonax minimus.*
Blue jay,	*Cyanocitta cristata.*
Baltimore oriole,	*Icterus galbula.*
Purple grackle or crow blackbird,	*Quiscalus quiscula.*

Chipping sparrow,	*Spizella socialis.*
Scarlet tanager,	*Piranga erythromelas.*
Red-eyed vireo,	*Vireo olivaceus.*
Yellow-throated vireo,	*Vireo flavifrons.*
White-eyed vireo,	*Vireo noveboracensis.*
Black-and-white warbler,	*Mniotilta varia.*
Yellow warbler,	*Dendroica æstiva.*
Chestnut-sided warbler,	*Dendroica pensylvanica.*
Oven-bird,	*Seiurus aurocapillus.*
Maryland yellow-throated warbler,	*Geothlypis trichas.*
American redstart,	*Setophaga ruticilla.*
Catbird,	*Galeoscoptes carolinensis.*
Brown thrasher,	*Harporhynchus rufus.*
House wren,	*Troglodytes ædon.*
White-bellied nuthatch,	*Sitta carolinensis.*
Chickadee,	*Parus atricapillus.*
Wood thrush,	*Turdus mustelinus.*
American robin,	*Merula migratoria.*
Blue bird,	*Sialia sialis.*
"English sparrow,"	*Passer domesticus* *

Number of Men Employed During the Season.

Jan. 1–Jan. 6,	82
Jan. 8–Jan. 13,	86
Jan. 15–Jan. 20,	85
Jan. 22–Jan. 27,	86
Jan 29–Feb. 3,	83
Feb. 5–Feb. 10,	82
Feb. 12–Feb. 13,	82
Feb. 14–Feb. 17,	23
Feb. 19–Feb. 24,	81
Feb. 26–March 3,	81
March 5–March 10,	82
March 12–March 17,	84
March 19–March 24,	85
March 26–March 31,	91
April 2–April 7,	95
April 9–April 14,	121
April 16–April 21,	157
April 23–April 28,	159
April 30–May 1,	156
May 2–May 9,	15
May 10–May 12,	164
May 14–May 19,	173
May 21–May 26,	213
May 28–June 2,	228
June 4–June 9,	230
June 11–June 16,	229
June 18–June 23,	225
June 25–June 30,	261
July 2–July 7,	265
July 9–July 14,	270
July 16–July 21,	265
July 23–July 28,	270
July 30–Aug. 4,	261
Aug. 6–Aug. 11,	266
Aug. 13–Aug. 18,	260
Aug. 20–Aug 25,	216
Aug. 27–Sept. 1,	15
Sept. 3–Sept. 8,	16
Sept. 10–Sept. 15,	147
Sept. 17 Sept. 22,	148
Sept. 24–Sept. 29,	133
Oct. 1–Oct. 6,	133
Oct. 8–Oct. 13,	131
Oct 15–Oct. 20,	123
Oct. 22–Oct 27,	125
Oct. 29–Nov. 3,	128

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* Although the "English sparrow" destroys some of the moths, it does more injury by driving away native birds than good by eating injurious insects; consequently the moths are most numerous where sparrows are plentiful.

Nov. 5-Nov. 10,	128	Dec. 3-Dec. 8,	132
Nov. 12-Nov. 17,	133	Dec. 10-Dec. 15,	134
Nov. 19-Nov. 24,	133	Dec. 17-Dec. 22,	135
Nov. 26-Dec. 1,	132	Dec. 24-Dec 29,	132

Work Done, and Results.

The table below pertains mainly to the hand-work of the year. Such results are given as can from their nature be tabulated. The number of different forms of the moth destroyed by such methods as burning and spraying cannot of course be determined. More than nine thousand of the moths recorded were males taken in traps.

Trees (fruit, shade and forest) : —	
Inspected,	6,828,229
Found to be infested with caterpillars, pupæ, moths or eggs,	48,752
Cleared of eggs,	2,176
In which cavities have been cemented or covered,	7,844
Burlapped,	624,673
Sprayed,	14,857
Trimmed,	8,618
Scraped,	6,068
Cut,	10,296
Acres of brushland and woodland cut and burned over,	336¼
Buildings : —	
Inspected,	27,430
Found to be infested,	508
Cleared of eggs,	55
Wooden fences : —	
Inspected,	35,276
Found to be infested,	798
Cleared of eggs,	99
Stone walls : —	
Inspected,	1,620
Found to be infested,	423
Cleared of eggs,	44
Number of each form of the moth destroyed during the year by hand : —	
Caterpillars,	1,153,560
Pupæ,	92,225
Moths,	18,084
Hatched or infertile egg-clusters,	18,036
Unhatched and probably fertile egg-clusters,	94,706

List of Places formerly infested from which the Moth has been apparently exterminated.

Beverly,
Brighton,
Burlington,
Charlestown,
Danvers,
Marblehead,
Reading,
Waltham,
Watertown
Woburn.

List of Cities and Towns still infested.

Arlington,
Belmont,
Boston,
Cambridge,
Chelsea,
Everett,
Lexington,
Lynn,
Lynnfield,
Malden,
Medford,
Melrose,
Peabody,
Revere,
Salem,
Swampscott,
Saugus,
Somerville,
Stoneham,
Wakefield,
Winchester,
Winthrop.

False Alarms.

During the season of 1894 fewer reports of the presence of supposed gypsy moths have been received from towns outside the infested region than in previous years. Yet some of these cases have been given such wide publicity that an erroneous impression of the spreading of the gypsy moth has been created. A citizen finds some insect injuring his orchard which bears some fancied resemblance to the gypsy moth. He immediately rushes into print with his discovery, and the local paper at once announces that "the gypsy moth has eluded the vigilance of the moth hunters, and has begun its ravages in this town." Such statements are widely copied and given out as facts. All cases of the kind which have come directly or indirectly to our notice have been investigated. In every instance the depredations noticed have been attributable to some other insect, and in no case has any evidence of the presence of the gypsy moth been found.

Towns and Cities that have been falsely reported as infested by the Gypsy Moth in 1894.

Andover,
Ashburnham,
Auburn,
Bedford,
Berlin,
Billerica,
Carlisle,
Chester,
Clinton,
Dedham,
Framingham,
Franklin,
Haverhill,
Holliston,
Lincoln,
Lowell,
Maynard,
Milton,
Monson,
Newton,
Norwood,
North Reading,
Rowley,
Scituate,
Springfield,
Sudbury,
Tewksbury,
Wayland,
Westborough,
Wilmington.

The Present Condition of the Infested Region.

The autumnal inspection of the outer towns of the infested region was so interrupted by snow-storms that it still remains uncompleted, and therefore no accurate report of the condition of the entire region can be made at this time. The ten outer towns which had previously been infested were apparently cleared in 1893. A close watch has been kept of these towns during the year, and a few caterpillars or egg-clusters have been found at some time during the year in most of them. Every vestige of the moth found in these towns has been destroyed, leaving them, with the exception of Lynnfield, still in the list of cleared towns. The discovery of these few moths in these towns emphasizes the need of keeping them under surveillance for a few years after they have been apparently cleared, and so long at least as there are moths in any of the adjacent towns. A protracted search of the wooded portion of southern Lynnfield has resulted in the discovery of several colonies heretofore unknown. As it will probably require two or three years' time to clear this woodland, Lynnfield must be retained in the list of infested towns. Woburn, on the other hand, which has been infested until recently, now appears clear, but it must be carefully watched.

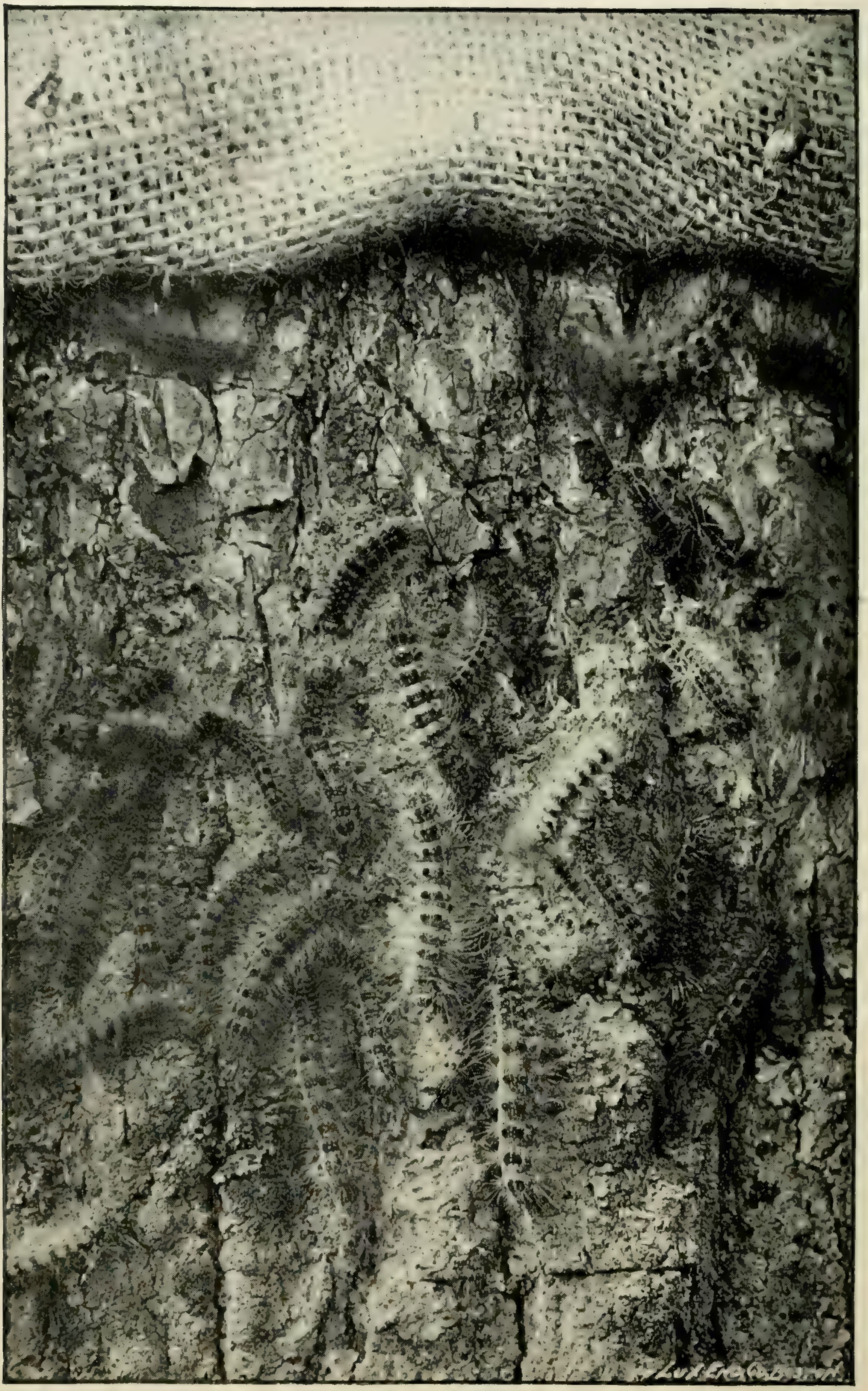
The moths have now been very nearly cleared from Swampscott, Salem, Peabody, Lexington, Somerville, Lynn and Winthrop, but there are still several localities in each of these towns which will require attention for some time to come. Each town ought also to be inspected thoroughly over its entire area in each of the few years next ensuing, to guard against the appearance of the moth in new localities. The condition of the towns in the central region as regards the numbers of the moth is as a whole considerably improved over that of last year. There are localities, however, in Malden, Medford, Chelsea, Saugus, Melrose, Arlington, Winchester and Stoneham, which should have received far more attention than it was possible to give them. In all of these towns there are large areas which are now practically clear of the moth. Large tracts of woodland in the north-central towns are believed to be more or less infested.

This has been reported to the Legislature for the past two seasons, and an appropriation sufficient to search this woodland has been recommended by the Board of Agriculture. But, as such an appropriation has not yet been made, it has been impossible to thoroughly examine all of this woodland. Until this can be done there will remain in this forested region an element of uncertainty and a menace to the success of the work. Everything possible under the circumstances and with the means at hand has been done to learn its condition and to suppress the moths wherever they were found. If the appropriation recommended by the Board is granted, there is every reason to believe that these woods can be carefully examined, their condition reported, and a good beginning made the coming year toward the extermination of the moth within their boundaries.

Respectfully submitted,

E. H. FORBUSH.

PLATE 4.



Section of burlap band raised, showing gypsy moth caterpillars that had gathered beneath it on the trunk of an elm tree.

From a photograph taken in Malden, Mass., July 9, 1892.

ENTOMOLOGIST'S REPORT.

To the Committee on the Gypsy Moth.

GENTLEMEN: — During the past season I have made frequent visits to the territory infested with the gypsy moth, and inspected the work with the greatest care. I have invariably found the work carried on in the most thorough manner, and in accordance with the most approved methods. I have been entirely satisfied with the progress of the work, and believe that all has been done that it was possible to accomplish with the appropriation made by the last Legislature. The citizens of this Commonwealth must not expect this insect pest to be exterminated if the Legislature continues to cut down the appropriation asked for more than one-third, as was done by the last two Legislatures, but must place the responsibility for any lack of success where it properly belongs.

There are some who believe that this insect can never be exterminated, but that the best thing to be done is to make a moderate annual appropriation to hold it in check, which means a perpetual warfare and a perpetual expense. Those who have been most familiar with the work from the first, and have carefully observed its progress in the various infested towns, are positive in their convictions that it is not only possible but feasible to exterminate the gypsy moth in the region known to be infested, in a term of years, if sufficient annual appropriations be made for this purpose. The sum total of these appropriations for the term of years required may seem large; but, when compared with the sum total of a perpetual annual appropriation sufficient to hold this insect in check, it sinks into utter insignificance.

It will undoubtedly be a stupendous undertaking to exterminate this pest, and will cost much more in the end than it would if the full appropriations asked for by the committee had been granted; but, nevertheless, it will be a far wiser policy to make the necessary appropriations for a term of years and completely exterminate the insect, than to allow it to become a perpetual expense to the people of this Commonwealth as well as to the whole country.

In the early part of the summer, by your direction, I invited Prof. F. L. Harvey of the Maine State College, Dr. G. H. Perkins of the University of Vermont, Prof. J. H. Comstock of Cornell University, Ithaca, N. Y., and Prof. L. O. Howard, entomologist of the Department of Agriculture, Washington, D. C., to visit the infested territory, inspect the work and give us any suggestions that might occur to them. I went to Malden with Dr. Perkins, and later with Professors Howard and Comstock, and together with Director Forbush went over the infested territory with them, giving them every possible opportunity to see the distribution and work of the insect, the apparatus and methods of destroying it and the various experiments then in progress. The reports which these gentlemen were so kind as to make are appended to this report.

A long series of experiments was conducted under my direction on insecticides, and their action on this peculiar insect and its life-history was more fully worked out than had been done before. Several new predaceous insects have been found destroying the caterpillars of the gypsy moth. These are: *Polistes pallipes* (St. Farg.), *Calosoma calidum* (Fab.), *Calosoma scrutator* (Fab.), *Calosoma sayi* (De J.), larvæ of *Harpalus caliginosus* (Fab.) and *Harpalus pennsylvanicus* (De G.), *Podisus cynicus* (Say), *Podisus serieventris* (Uhl.) (the last two determined by Professor Uhler); and two species of ants were found destroying the caterpillars, and the females also while laying their eggs were sometimes destroyed by these ants. Mr. Pergande determined these ants to be *Camponotus pennsylvanicus* (De G.) and *Formica subsericea* (Say). Large and small workers of this last species were both found destroying the gypsy moth. Several species of Diptera were bred from the gypsy moth, and have been referred to Dr. Williston for determination. A species of Hymenoptera, which was given in the report for 1893 under the name of *Meraporus* sp.? was bred in considerable numbers from the pupæ, and has now been determined by Messrs. Howard and Ashmead as *Diglochis omnivorus* (Walk.), a European species which is parasitic on many different species of insects, as indicated by its specific name.

In accordance with the provisions made by the last Legislature, we are preparing a report, to include as far as possible all existing knowledge of the gypsy moth, its history and habits, both in Europe and this country, and all practical and scientific information that can be of assistance in destroying this insect.

Respectfully submitted,

C. H. FERNALD.

APPENDIX.

REPORT OF DR. GEORGE H. PERKINS OF THE UNIVERSITY OF VERMONT, ENTOMOLOGIST OF THE VERMONT STATE AGRICULTURAL EXPERIMENT STATION.

BURLINGTON, VT., July 10, 1894.

Prof. C. H. Fernald.

DEAR SIR: — In accordance with your invitation to visit the region infested by the gypsy moth, I went to Malden, as you are aware, and through the very cordial assistance of both yourself and Mr. Ware, assistant director, was enabled to see in a most complete and satisfactory manner the appliances used and the various methods of using them.

I wish to express my appreciation of the thorough and careful manner in which the work was being done, and the evident desire of those engaged in it to execute the trust committed to them as faithfully and economically as possible. No work of the sort which I have ever seen or heard of has impressed me as favorably as did that of the officials engaged in the work of exterminating the gypsy moth.

The whole nation should be grateful to the committee for what it has already accomplished; for it is my belief that, had not the work been so well done in Massachusetts, the insect would ere this have spread beyond the borders of that State and now threaten the whole land. It is most gratifying to find, instead of this, that the ravages of the moth have been very much reduced by the efforts of the committee.

No one interested in economic entomology can investigate the work in office and field without at once discovering that a vast amount of very useful information has been gathered which should not on any account be lost to science. On this account it is very greatly to be desired that as full and complete a report as possible of the work of the committee be published, for much that such a report would contain would necessarily be of general and permanent value.

The question has been asked, Is it possible to exterminate an

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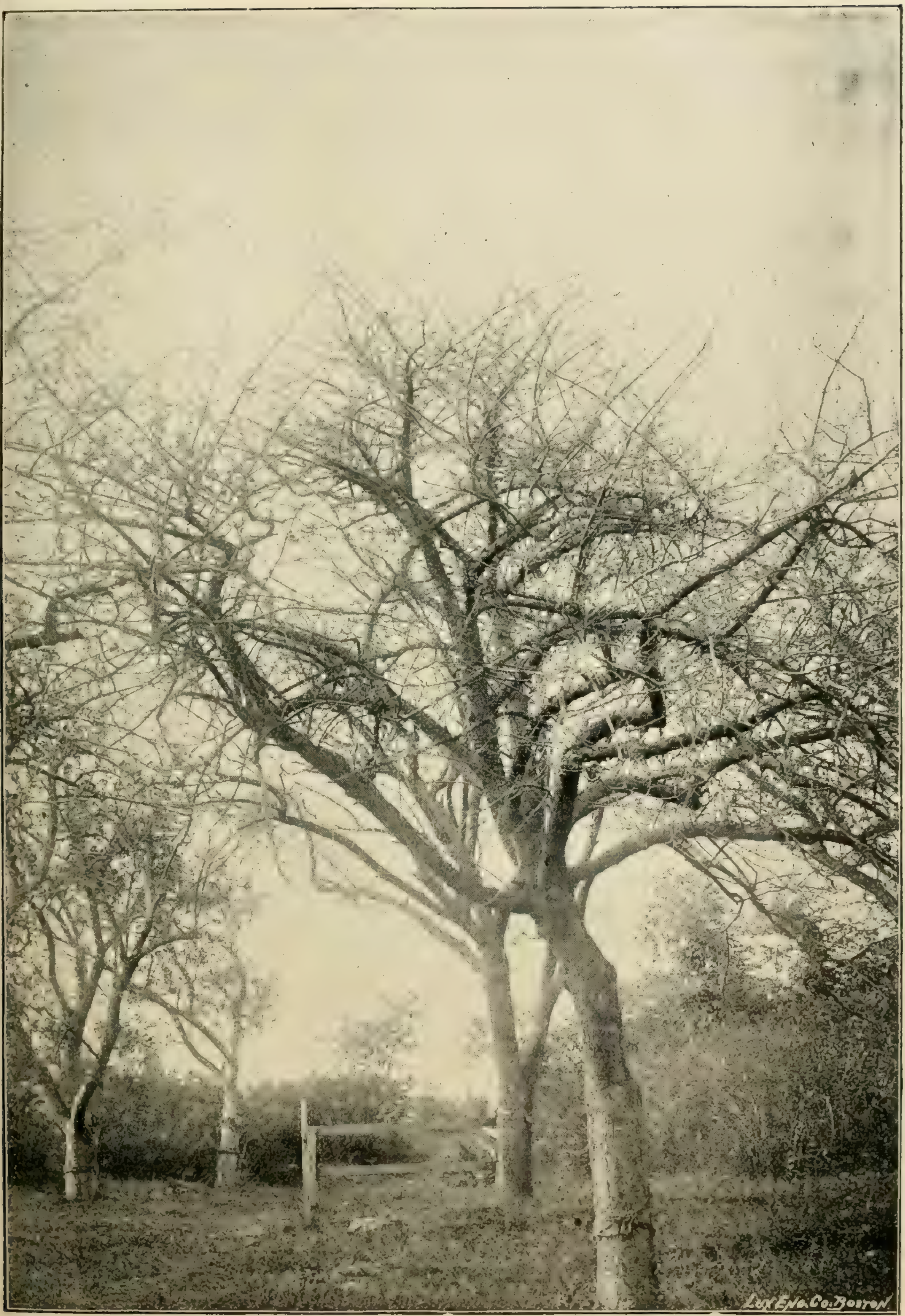
LUX ENG. CO. BOSTON

Apple orchard stripped by caterpillars of the gypsy moth, Swampscott, Mass.
From a photograph taken Aug. 5. 1891.

insect which has become so abundant as the gypsy moth? Before I visited the infested region, and saw what had already been done, I was quite doubtful as to the expediency or the possibility of extermination; but after investigation I thought differently. It seems to me very clearly the wisest and most economical course, for the present at any rate, to continue the work as it is now going forward, and aim at extermination. The men and the methods now employed are so successful that it would be unwise to discontinue them for several seasons to come.

It also seems to me that the functions of the committee might be very advantageously extended, so that in their discretion they could direct their destructive agencies against such other insects as might be easily taken in hand.

When passing through some of the towns infested by the gypsy moth we noticed many trees the foliage of which had been wholly destroyed by the canker worm; and many of these trees could have been sprayed by those engaged in spraying neighboring trees for the moth at small cost of time or money.

It was very evident that private enterprise could not be depended upon to deal with these pests. It is my own conviction that the most efficient and the cheapest method of dealing with any insect which has become numerous and destructive is that adopted in the case of the gypsy moth, not leaving to private citizens the too great task, and thus ensuring failure, but bringing the authority and the resources of the State to the work, and carrying it forward to success.

Is it not probable that, had the gypsy moth not been stayed in its destruction, the loss to property through the destruction of shade and fruit trees would have been more than the cost of extermination has thus far been?

It is to be hoped that the work so well done thus far will not now be suffered to lag through lack of either funds or popular support. There is every reason for continuing it, while to stop or reduce it would be a great calamity.

I have not been asked to praise the work of the committee, but rather to suggest improvements in their methods, and to criticise whatever I might find deserving it. I have no criticism to offer, nor am I able to make suggestions other than those given above.

I am, sir, very truly yours,

GEO. H. PERKINS.

REPORT OF PROF. F. L. HARVEY, BOTANIST AND ENTOMOLOGIST, MAINE EXPERIMENT STATION, ORONO, ME.

To the Members of the Gypsy Moth Committee of the State Board of Agriculture of Massachusetts.

GENTLEMEN: — In compliance with your courteous invitation (extended to me through Prof. C. H. Fernald) "to inspect the work of the gypsy moth committee and give my impressions and advice," I visited Malden the latter part of July, and spent two days examining the work of the committee in the office, laboratories and field. Through the courtesies of Director E. H. Forbush and others of the department every opportunity was afforded me to gain a thorough knowledge of the scope and character of the work of the committee.

I went to Malden with an entirely inadequate conception of the territory affected, and the stupendous undertaking of the committee to reduce or exterminate the gypsy moth. I first visited the office, and was surprised by the ingenuity and thoroughness displayed in keeping the field notes and indexing them for ready reference. A mass of information regarding the habits, natural history and anatomy of this insect has been accumulated by Professor Fernald, Director Forbush and their assistants. This seems so important that for the good of entomological science it is hoped it may be sifted by a competent entomologist and published as a monograph by the committee. The pains taken in examining the men for field work and the almost military exactness required of them in their labor and reports reflect great credit upon the organizing ability of the director, and speak much for the efficiency of the service.

The work being done in the laboratory and insectary upon the life-history of the moth, its parasites and histology, and upon remedies, was timely and thorough. I was especially interested in the histological work, conducted by Mr. A. H. Kirkland, to determine if possible what becomes of the arsenical poison the full-grown larvæ are known to eat with impunity, and also the trap experiments under the direction of Mr. Kirkland.

The store-house for apparatus and supplies impresses one with the magnitude of the work, and is instructive in the novel apparatus invented to fight this pest.

The results obtained in the experiments on insecticides, by Mr. F. C. Moulton, are most important, and bid fair to be of great usefulness to economic entomology.

The field methods of searching for the eggs, larvæ and pupæ, the burlapping of the trees and the careful burning of infested areas was thorough and practical.

Upon the whole, the methods which have been born of experience and adopted by the committee for coping with the pest impressed me as ingenious and effective. I have no criticisms to offer upon the work of the committee, and regard the results obtained as marvellous.

Entomologists are generally agreed that it is impossible to exterminate an insect by means of its parasites, so all that can be hoped for in this direction is *uncertain* aid in holding it in check. Whether it is possible to exterminate an insect by persistent and thorough hand-picking, use of insecticides and fire is problematical, because it has never been tried. It is a *plausible* problem, which we hope, for the good of economic entomology, the gypsy moth committee may have the opportunity to settle. By the efficient work of the committee, in three years' time, this insect, which was legion and doing great damage over a wide area, has been reduced beyond detection by common observation. We spent a whole day in the field, and, though constantly on the alert for specimens, saw only four male moths and no larvæ, pupæ or eggs. So thoroughly has the work been done that intelligent people in the district *wrongly* regard the work of the committee accomplished. It is the scattering colonies, the last one per cent, that will demand more thorough work than the other ninety-nine per cent, and your Legislature and citizens will need to be thoroughly impressed with this fact.

Two policies present themselves: first, whether an attempt be made to fight the moth to the finish; second, whether an attempt be made to merely keep it in check, and prevent an increase to harmful numbers.

The gratifying work of the committee so far would suggest continuance in the good work, with the idea of extermination. This would *absolutely* require the employment of a force of men large enough to keep the whole infested area under constant surveillance for some time. The present number of men employed seems to me to be inadequate, as large areas in the infested district have to be neglected while inspection is going on in others. Unless a large force can be kept constantly employed for some years, the idea of extermination will have to be *abandoned* by the committee.

If the second policy be adopted, then the work of the committee for the present is practically done. Yet a permanent force would be needed to keep the area under occasional surveillance, and its energies directed to checking local outbreaks. This would be an interminable job, constantly menaced with the danger of the pest spreading over large areas to adjoining States, until so widely disseminated as to be beyond human power to control. It would seem to me to be wiser to attempt the extermination of the pest while in its greatly reduced numbers by the adoption of a liberal financial policy, than to drop the work and in a decade or sooner have it to do all over again.

We regret to learn (unofficially) that naturalists are breeding this pest for purposes of study outside of the Commonwealth of Massachusetts, in defiance of the strict laws regarding its dissemination.

I heard the committee criticised by citizens and others because they would not destroy other injurious insects besides the gypsy moth in the infested district. We understand this criticism to be *unjust*, as the Legislature defined the duties of the committee strictly to the suppression of this *one* insect, and to use the money to destroy the others would be a perversion of funds.

That it would be a wise policy for every State to have an entomological commission, with duties as broad as the requirements of economic entomology, we have no doubt. The fact that the gypsy moth committee has paid strict attention to business is the reason why they have in such a short time accomplished so much.

In closing, I desire to thank the committee for the opportunity offered me to study the life-history of this insect, and to become familiar with the ingenious and effective methods used in coping with it. I hope the committee will receive the financial support from the Legislature that will enable it to succeed in this stupendous undertaking, which does not alone interest Massachusetts, but also the adjoining States and the whole country.

Respectfully submitted,

F. L. HARVEY.

REPORT OF PROF. JOHN H. COMSTOCK, CORNELL UNIVERSITY, ITHACA, N. Y.

ITHACA, N. Y., July 17, 1894.

Mr. WILLIAM R. SESSIONS, *Secretary of the Committee on the Extermination of the Gypsy Moth of the State Board of Agriculture.*

SIR: — In compliance with the request of your committee, transmitted to me through Professor Fernald, I visited the region infested by the gypsy moth, and spent several days studying what is being done towards the extermination of this species. During the greater part of this time I was accompanied by Professor Fernald and Mr. E. H. Forbush, who explained to me very fully the details of the work.

I was filled with admiration of the work that is being done by these gentlemen, and, although I have given the matter very careful thought, I am unable to suggest any changes in their methods. It seems to me that the methods they are following are the best possible, so long as the object of the work is the extermination of this insect.

But, after going over the infested region, I have come to have grave doubts as to the advisability of attempting to exterminate this pest. I am not prepared to say that I consider extermination impossible, but it seems to me that the attainment of this desired end is highly improbable. It is true there are certain peculiarities in the habits of this insect that give hopes of the possibility of extermination. Thus the slowness with which the species spreads naturally, owing to the fact that the female does not fly, and the fact that the larva in its later stages descends from the trees and hides during the day-time, rendering it possible to trap it, greatly facilitate the work of destruction. On the other hand, the wide range of food plants, the extent of the area infested, including as it does large forests, and the ease with which the species may be artificially spread by means of vehicles, all combine to make the task a very great one. Still, if you could be provided with sufficient funds extending over a sufficiently long period, I believe these difficulties could be overcome.

But I feel that this is too much to hope. If at this time, so soon after the terrible ravages of the pest, the Legislature appropriates less than two-thirds of the sum which your committee, after careful investigation, deems necessary to carry on the work, it is hardly probable that succeeding Legislatures would furnish the means necessary to carry this work to a conclusion, involving as it would a large outlay for many years after the insect had ceased to be a pest. As I do not believe that the financial support would be furnished you, I respectfully suggest that you consider the advisability of adopting a different method of combating the pest. Much of the work that is being done now would be unnecessary if the object was merely to keep the insect from being unduly destructive. And, if there is no hope of your receiving the support necessary to exterminate the insect, the continuance of the present methods would certainly involve a large unnecessary expenditure.

It is probable that if your warfare against this insect was restricted to those localities in which its injuries are of a serious nature, its natural enemies would greatly increase and tend to keep it in check. Already a considerable number of parasites is known to infest it. There will be a tendency for them to increase, so that in time serious outbreaks of this pest will probably be only occasional and in limited areas. Such outbreaks could be easily subdued.

While I believe that a change in the object of the work of your committee seems imperative, I would not consider for a moment the giving up of your warfare against the pest, but would advise its continuance in the following manner: I would suggest no change in the organization for carrying on the entomological work of the State. A committee of the State Board of Agriculture, constituted as is your committee, seems to me to be the most appropriate organization for this purpose. I would, however, recommend the broadening of the scope of the work of this committee, so that it should have authority to deal with any serious outbreak of insect pests. I will not presume to indicate in detail the method of conducting this work, beyond suggesting that in their more general features the horticultural laws of the State of California might serve as a model.

Very respectfully, your obedient servant,

J. H. COMSTOCK.

Extract from the President's Address by L. O. Howard, Entomologist of the United States Department of Agriculture, delivered before the Sixth Annual Meeting of the Association of Economic Entomologists, Brooklyn, Aug. 14, 1894.*

The work upon the gypsy moth, by the way, which has been done by the State of Massachusetts since 1889, is one of the most remarkable pieces of work, judging by results, which has yet been done in economic entomology. The operations have been carried on by a committee of the State Board of Agriculture, and the means have been furnished by large annual appropriations by the State Legislature. Three hundred and twenty-five thousand dollars have already been appropriated.

A territory comprising something over one hundred square miles was infested by the insect, which occurred in such extraordinary numbers as to destroy many trees and almost to threaten the ultimate extinction of living vegetation, not only within the infested territory, but in all localities to which it might spread. It is unnecessary to detail the steps by which relief was brought about. Mistakes were undoubtedly made at first, and it is to the work of the present committee that the main credit is due. The infested territory has been reduced by one-half, and within the districts in which the gypsy moth at present exists, it is, practically speaking, a comparatively rare species.

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* Insect Life, Vol. vii., No. 2, page 59.

The future of the insect is, however, problematical. The continuance of sufficiently large appropriations from the State Legislature to enable the work to be carried on on its present scale is doubtful, and yet those in charge believe that still larger appropriations are necessary to bring about extermination. They are confident, however, that with sufficient means the insect can be absolutely exterminated from the State of Massachusetts. With the Legislature disinclined to continue the large appropriations, the methods of the committee at present pursued will have to be seriously altered. Given a small appropriation of say $25,000 annually, it will become necessary to adopt some law, like that enforced in California, whereby much less frequent inspection may be made, and the committee will have to rely in part upon voluntary observers for information. Moreover, they will be unable to conduct spraying operations upon a large scale, and the expense of the destruction of insects will have to be assessed upon the owners of the property upon which the insects are found, provided such owners will not themselves undertake the destruction of the insects. There will be many disadvantages from such a course, and in the case of unproductive lands the expense will be so great that the owner will prefer confiscation. Between some such course as this and the continuance of the present methods, however, there seems to be little choice, since if the appropriation were taken away the insect will not only speedily reach its former destructive height, but will spread far and wide over the country.

It may be urged that it will be only a few years before the insect will take its place as a naturalized member of our fauna, and will become subject to the same variations of increase and decrease as our native species, and that it will, in fact, become little more to be feared than species already existing with us, particularly if its European natural enemies are introduced. Against this view, however, it must be urged that the gypsy moth seems an exceptionally hardy species, and that even in Europe it is a prime pest. The caterpillar is tough and rugged, and seems little subject to disease and to climatic drawbacks, and is wonderfully resistant to the action of ordinary insecticides. The gypsy moth larva will feed for days without apparent injury upon trees which have been sprayed with Paris green or London purple in a solution so strong as to somewhat burn the leaves. In fact, the committee, in the spraying which they are carrying on at present, have found it necessary to use arsenate of lead in as strong proportion as ten pounds to one hundred and fifty gallons of water. The well-known vitality of previously introduced European injurious insects is apparently increased to a striking degree by this species, while the fact that it feeds on nearly all plants renders it a much more serious pest than any of its forerunners. Under these circumstances, therefore, any course other than energetic and well-directed effort to keep the insect within its present boundaries will be short-sighted in the extreme, although it is very doubtful to my mind whether absolute extermination will or can ever be brought about.

FINANCIAL RETURNS

AND

ANALYSES OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH MEMBERSHIP AND INSTITUTES
FOR THE YEAR 1894.

RETURNS OF SOCIETIES.

AMESBURY AND SALISBURY AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1881, Acts of 1881, chapter 204.

Originally raised by contribution $1,002.32; now has $7,610 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $7,755.28: real estate, $7,370.12; crockery, tables, etc., $239.89; cash on hand, $145.27. Total liabilities consist of notes amounting to $1,900. Receipts in 1894, $2,256.82: bounty, $600; new members, $83; donations, $2.50; other sources, $1,571.32. Expenditures in 1894, $2,111.55: premiums and gratuities paid, $528.15; current running expenses, $62.79; interest, $139.29; other expenses, $1,057.32. The society offered in premiums $1,500, awarded $855.90 in premiums and gratuities and paid $852.15, which went to 15 cities and towns. Eighty-four dollars and fifty cents went to three towns outside the State. Three hundred and twenty-five persons received premiums and 261 gratuities. Under head of farms $26 was awarded and paid; under farm and pet stock $386 was awarded and paid; under field and experimental crops $5 was awarded and paid; under farm and garden products $178.65 was awarded and $176.90 paid; under dairy products $3.75 was awarded and paid; under domestic manufactures $107 was awarded and $104.25 paid; under objects strictly agricultural, not specified, $29 was awarded and paid; under objects other than agricultural, not specified, $122.25 was awarded and $121.25 paid. The society reports 230 members, — 203 males and 27 females. Four farmers' institutes were held at Amesbury: January 16, on "The Horse's foot and its diseases" and "Hygiene of farm animals;" January 30, on "Practical poultry culture" and "Corn culture for feed;" February 20, on "Stock feeding and fertilizers;" and March 7, on "Corn culture" and "General fruit culture."

ATTLEBOROUGH AGRICULTURAL ASSOCIATION.

Incorporated 1887, Acts of 1887, chapter 203.

Originally raised by contribution $20,000, which is now invested as a capital stock in real estate. Total assets, $25,002.82: real estate, $24,500; crockery, tables, etc., $500; cash on hand $2.82. Total liabilities, $8,653.04: premiums due and unpaid, $86.58; outstanding bills, $1,066.46; mortgages or like liabilities, $7,500. Receipts in 1894, $4,117.45: bounty, $600; donations, $53.95; other sources, $3,463.50. Expenditures in 1894, $5,810.80; premiums and gratuities paid, $1,658.76; current running expenses, $350; interest, $450; other expenses, $3,352.04. The society offered in premiums $2,670.90, awarded in premiums and gratuities $1,773.80 and paid $1,658.76, which went to 35 cities and towns. Four hundred and sixty-three dollars went to 13 cities and towns outside the State. Two hundred and eighty-five persons received premiums and gratuities. Under head of farm and pet stock $555 was awarded and $516.75 paid; under field and experimental crops $30 was awarded and $27 paid; under farm and garden products $174.25 was awarded and $151.42 paid; under domestic manufactures $179.05 was awarded and $155.34 paid; for firemen's muster $400 was awarded and paid; under trotting $790 was awarded and paid; for objects other than agricultural, not specified, $45.50 was awarded and $28.50 paid. The society reports 104 members, — 95 males and 9 females. Three farmers' institutes were held: at Wrentham, March 26, on "Composition of milk;" at "Franklin, May 1, on "The usefulness of agricultural organizations;" and at Attleborough, December 13, on "Tuberculosis."

BARNSTABLE COUNTY AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 114.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $1,740; now has $8,300 invested as a capital stock in real estate and bonds. Total assets, $8,514.14: real estate, $7,500; bonds,

$800; cash on hand, $214.14. Total liabilities, $3,635: outstanding bills, $60; notes, $3,575. Receipts in 1894, $3,875.78: bounty, $600; bonds, $20; new members, $20; donations, $116.75; other sources, $3,119.03. Expenditures in 1894, $3,661.64: premiums and gratuities paid, $1,608.85; current running expenses, $1,137.07; interest, $184.25; other expenses, $731.47. The society offered $2,040.25 in premiums, and awarded and paid $1,608.85 in premiums and gratuities, which went to 17 cities and towns. One hundred and twenty-five persons received premiums and 114 gratuities. Under head of farm and pet stock $315.55 was awarded and paid; under field and experimental crops $52 was awarded and paid; under farm and garden products $205.15 was awarded and paid; under dairy products $9 was awarded and paid; under domestic manufactures $149.15 was awarded and paid; under agricultural implements $13 was awarded and paid; under trotting $770 was awarded and paid; under objects other than agricultural, not specified, $95 was awarded and paid. The society reports 553 members, — 333 males and 220 females. Three farmers' institutes were held: at East Sandwich, February 2, on "Commercial fertilizers in relation to stable manure;" at Yarmouthport, February 24, on "General fruit culture;" and at Barnstable, November 22, on "Tuberculosis in cattle."

BERKSHIRE AGRICULTURAL SOCIETY.

Incorporated 1811, Acts of 1811, chapter 70.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $3,000; now has $15,000 invested as a capital stock in real estate. Total assets, $15,352.67: real estate, $15,000; bills due and unpaid, $346.50; cash on hand, $6.17. Total liabilities, $9,645.73: premiums due and unpaid, $51.50; outstanding bills, $614.23; mortgages or like liabilities, $8,000; interest, $480; loan, $500. Receipts in 1894, $6,318.98: bounty, $600; loan, $500; new members, $20; donations, $30; other sources, $5,168.98. Expenditures in 1894, $6,359.98: premiums and gratuities paid, $2,919.32; current running expenses, $3,401.58; interest, $37.07. The society offered $3,312.32 in premiums, awarded $2,792.82 in premiums and gratuities, and paid $2,741.32, which went to 24 cities and towns. Twenty-two dollars went to two towns outside the State. Three hundred and seven persons received premiums and 2 gratuities. Under head of farms $33 was awarded and paid; under farm and pet stock $734 was awarded and paid; under farm and garden products $260.50 was awarded and $258.50 paid; under dairy products $20 was awarded and paid; under domestic manufactures $229.50 was awarded and paid; under trotting $1,404.82 was awarded and paid; under objects other than agricultural, not specified, $73 was awarded and paid. The society reports 1,151 members, — 1,041 males and 110 females. Three farmers' institutes were held: at Pittsfield, February 16, on "Tuberculosis in cattle;" at Richmond, February 21, on "Grasses and forage crops" and "Manures and fertilizers and their use;" and at New Lenox, February 28, on "Raising of cream" and "Dairy farming."

BLACKSTONE VALLEY AGRICULTURAL SOCIETY.

Incorporated 1884, Acts of 1884, chapter 48.

Originally raised by contribution $3,000; now has $4,500 invested as a capital stock in real estate. Total assets, $4,518.50: real estate, $4,500; cash on hand, $18.50. Total liabilities consist of mortgages or like liabilities to the amount of $1,600. Receipts in 1894, $1,754.25: bounty, $600; new members, $32; donations, $26.40; other sources, $1,095.85. Expenditures in 1894, $2,223.16: premiums and gratuities paid, $996; current running expenses, $1,193.38; interest, $33.78. The society offered in premiums $1,178, and awarded and paid in premiums and gratuities $996, which went to 17 cities and towns. Two dollars and twenty-five cents went to one city outside the State. One hundred and sixty-four persons received premiums and 21 gratuities. Under head of farms $130 was awarded and paid; under farm and pet stock $642.50 was awarded and $634 paid; under field and experimental crops $25 was awarded and $21.50 paid; under farm and garden products $62.35 was awarded and $59.25 paid; under dairy products $6.50 was awarded and $6 paid;

under domestic manufactures $53.30 was awarded and $51 paid; under objects other than agricultural, not specified, $49.65 was awarded and $47.65 paid. The society reports 482 members, — 280 males and 202 females. Three farmers' institutes were held at Uxbridge: January 23, on "Japan, its farms and farmers;" February 7, on "Hygiene of farm animals;" March 13, on "Production of milk."

BRISTOL COUNTY AGRICULTURAL SOCIETY.

Incorporated 1823, Acts of 1823, chapter 32.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $3,240; now has $32,000 invested as a capital stock in real estate. Total assets, $32,706.61: real estate, $32,000; crockery, tables, etc., $200; cash on hand, $506.61. Total liabilities, $14,100: outstanding bills, $100; mortgages or like liabilities, $14,000. Receipts in 1894, $14,589.37: bounty, $600; new members, $85; other sources, $13,904.37. Expenditures in 1894, $15,332.27: premiums and gratuities paid, $4,568; current running expenses, $4,512.95; interest, $873.75; other expenses, $5,377.57. The society offered $5,878 in premiums, awarded $4,677 and paid $4,568, which went to 39 cities and towns. Three hundred and four dollars and five cents went to 7 cities and towns outside the State. Eight hundred and eighty-four persons received premiums. Under head of farms $60 was awarded and paid; under farm and pet stock $1,318 was awarded and $1,218 paid; under field and experimental crops $30 was awarded and paid; under farm and garden products $286 was awarded and paid; under dairy products $35 was awarded and paid; under domestic manufactures $333.70 was awarded and paid; under agricultural implements $50 was awarded; under trotting $2,400 was awarded and $2,370 paid; under objects other than agricultural, not specified, $275 was awarded and $118 paid. The society reports 879 members, — 684 males and 195 females. Three farmers' institutes were held: at Swansea, March 15, on "Feed the plant and the plant will feed you;" at Norton, March 16, on "Fruit culture;" and at Dighton, March 21, on "Practical poultry culture" and "Dairying."

DEERFIELD VALLEY AGRICULTURAL SOCIETY.

Incorporated 1871, Acts of 1871, chapter 208.

Originally raised by contribution $4,094.01; now has $9,200 invested as a capital stock in real estate. Total assets, $9,519.40: real estate, $9,200; crockery, tables, etc., $250; bills due or unpaid, $69.40. Liabilities consist of mortgages and like liabilities to the amount of $1,144.40. Receipts in 1894, $1,825.11: bounty, $600; new members, $86; donations, $5.90; other sources, $1,133.21. Expenditures in 1894, $1,825.11: premiums paid, $978; current running expenses, $792.70; interest, $54.41. The society offered in premiums $1,125.75, awarded $978 and paid $973, which went to 27 cities and towns. One dollar and fifty cents went to one town outside the State. Two hundred and twenty-five persons received premiums. Under head of farm and pet stock $625.65 was awarded and $624.15 paid; under farm and garden products $70 was awarded and $68 paid; under dairy products $17 was awarded and paid; under domestic manufactures $71.10 was awarded and $68.70 paid; under trotting $150 was awarded and paid; under objects other than agricultural, not specified, $44.25 was awarded and paid. The society reports 1,330 members, — 1,220 males and 110 females. Three farmers' institutes were held: at Charlemont, January 20, on "How to improve our schools" and "Roads;" at Ashfield, February 24, on "Education" and "Taxation;" and at Buckland, March 10, on "Tuberculosis in cattle."

EASTERN HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 156.

Originally raised by contribution $3,000; now has $7,000 invested as a capital stock in real estate. Total assets, $7.089.09: real estate, $7,000; cash, $89.09. Total liabilities consist of a note for $2,800. Receipts in 1894, $1,928.61: bounty, $600; new members, $23; donations, $48.46; other sources, $1,321.15. Expenditures in 1894, $1,839.52: premiums and gratuities paid, $1,067.07; current running expenses, $489.85; interest, $151.93; other expenses, $130.67. The society offered in premiums $1,560.20 and awarded and paid $1,067.07 in premiums and gratuities, which went to 15 cities and towns. One hundred and forty-two persons received premiums and gratuities. Under head of farms $10 was awarded and paid; under farm and pet stock $439.75 was awarded and paid; under farm and garden products $128.45 was awarded and paid; under dairy products $6 was awarded and paid; under domestic manufactures, $50.87 was awarded and paid; under trotting $405 was awarded and paid; under objects other than agricultural, not specified, $27 was awarded and paid. The society reports 462 members,—260 males and 202 females. Three farmers' institutes were held: at Palmer, January 16, on "Manures and fertilizers;" at Monson, March 6, on "Farm dairying;" and at Palmer, March 27, on "Fruit culture in Massachusetts."

ESSEX AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 25.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $9,363.66; now has $20,866 invested as a capital stock in real estate, stocks, bonds, crockery, tables, etc. Total assets, $19,533.05: real estate, $5,000; stocks, $13,333.05; bonds, $1,000; crockery, tables, etc., $200. Receipts in 1894, $2,071.60: bounty, $600; stocks, $850.48; bonds, $60; new members, $60; other sources, $501.12. Expenditures in 1894, $2,709.35; premiums paid, $1,595.75; current running expenses, $1,019.85; interest, $93.75. The society offered in premiums $3,315.50, awarded $1,691.75* and paid $1,595.75,* which went to 28 cities and towns. Three hundred and sixty-one persons received premiums. Under head of farms $107 was awarded and $123 paid; under farm and pet stock $693 was awarded and $659 paid; under field and experimental crops $155 was awarded and $75 paid; under farm and garden products $500.50 was awarded and $362.25 paid; under dairy products $24 was awarded and $9 paid;

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* Amounts paid for 1893; awarded for 1894.

under domestic manufactures $174.50 was awarded and $138.50 paid; under agricultural implements, $50.50 was awarded; under objects strictly agricultural, not specified, $45 was awarded; under objects other than agricultural, not specified, $83 was awarded and $192.50 paid. The society reports 1,516 members,—1,511 males and 5 females. Four farmers' institutes were held: at Danvers, January 5, a field institute was held; at Beverly, January 26, on "How to feed the dairy cow for milk and cream production; the skim-milk and how to use it" and "The work of the State Board of Agriculture;" at Newbury, February 16, on "Small fruits" and "State Highway Commission and highways;" at Haverhill, March 23, on "Dairy work in its general forms."

FRANKLIN COUNTY AGRICULTURAL SOCIETY.

Incorporated 1850, Acts of 1850, chapter 104.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,768; now has $7,020 invested as a capital stock in real estate and bank stock. Total assets, $7,363.93: real estate, $6,000; stocks, $1,020; bank funds, $132.93; crockery, tables, etc., $80; bills due and unpaid, $131. Total liabilities, $353.25: premiums due and unpaid, $53.25; mortgages or like liabilities, $300. Receipts in 1894, $4,082: bounty, $600; stocks, $52.11; bank funds, $1.52; new members, $60; donations, $391; other sources, $2,977.37. Expenditures in 1894, $3,949.07: premiums and gratuities paid, $1,390; current running expenses, $1,158.56; other expenses, $1,400.51. The society offered in premiums $1,615.50, awarded in premiums and gratuities $1,429.50 and paid $1,376.25, which went to 20 cities and towns. Fifty cents went to 1 city outside the State. Two hundred and fifty-six persons received premiums and 5 gratuities. Under head of farm and pet stock $1,067.50 was awarded and $1,036.75 paid; under farm and garden products $170.75 was awarded and $169.50 paid; under dairy products $33 was awarded and $23 paid; under domestic manufactures $125.75 was awarded and $119 paid; under trotting $450 was awarded and paid; under objects other than agricultural, not specified, $30 was awarded and $28 paid. Diplomas were awarded for agricultural implements. The society reports 1,800 members, — 1,500 males and 300 females. Three farmers' institutes were held: at Greenfield, January 20, on "Fodder crops for farm live stock;" at Greenfield, February 3, on "The management of milch cows;" and at Conway, February 14, on "Plant food; science and art of manuring," "Composition and food value of milk" and "The pleasures of farming."

HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 56.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $4,860; now has $1,144 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $1,144: real estate, $750; crockery, tables, etc., $150; cash on hand, $244. Receipts in 1894, $1,631.80: bounty, $228.80; new members, $30; donations, $51; other sources, $1,322. Expenditures in 1894, $1,886.45: premiums and gratuities paid, $447.88; current running expenses, $1,419.42; other expenses, $19.15. The society offered in premiums $1,292.75, awarded in premiums and gratuities $540.40 and paid $447.88, which went to 12 cities and towns. One hundred and eighteen persons received premiums and 3 gratuities. Under head of farms $10 was awarded and paid; under farm and pet stock $267 was awarded and $189.25 paid; under farm and garden products $129.25 was awarded and $105.88 paid; under dairy products $2 was awarded and paid; under domestic manufactures $34.50 was awarded and $19 paid; under agricultural implements $23 was awarded and $19 paid; under objects strictly agricultural, not specified, $25.75 was awarded and paid; under trotting $200 was awarded and paid; under objects other than agricultural, not specified, $39 was awarded and $28 paid. The society reports 633 members, — 517 males and 116 females. Three farmers' institutes were held: at Westfield, January 26, on "Fertilizers for tobacco" and "Roads and their improvement;" at Wilbraham, February 14, on "Small fruits" and "Propagation of the apple;" and at West Springfield, March 14, on "Manures and fertilizers and their use."

HAMPSHIRE AGRICULTURAL SOCIETY.

Incorporated 1814, Acts of 1814, chapter 19.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,255,26; now has $4,150 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $4,196.70: real estate, $4,000; crockery, tables, etc., $150; cash on hand, $46.70. Total liabilities, $951: outstanding bills, $51; mortgages or like liabilities, $900. Receipts in 1894, $2,135.04: bounty, $600; new members, $60; donations, $203.17; other sources, $1,271.89. Expenditures in 1894, $2,088.34: premiums and gratuities paid, $827.92; current running expenses, $355.35; interest, $50.75; other expenses, $854.32. The society offered in premiums $1,006, and awarded and paid in premiums and gratuities $827.92, which went to 16 cities and towns. One hundred and twenty-one persons received premiums and 11 gratuities. Under head of farm and pet stock $370 was awarded and paid; under field and experimental crops $25 was awarded and paid; under farm and garden crops $195.25 was awarded and paid; under dairy products $32 was awarded and paid; under domestic manufactures $107.35 was awarded and paid; under trotting $465 was awarded and paid; under objects other than agricultural, not specified, $7 was awarded and paid. The society reports 795 members, — 560 males and 235 females. Three farmers' institutes were held: at Sunderland, March 28, on "Taxation and the farmer" and "Manures and fertilizers and their use;" at Sunderland, December 20, on "The unemployed" and "How to protect fruits and garden crops from insects;" and at Amherst, December 26, on "Tuberculosis."

HAMPSHIRE, FRANKLIN AND HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 125.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $8,141.29; now has $3,032.72 invested as a capital stock in personal property. Total assets, $3,052.72: real estate lease, $3,020; bills due and unpaid, $20; cash on hand, $12.72. Liabilities consist of premiums due and unpaid and outstanding bills to the amount of $600. Receipts in 1894, $3,008.80: bounty, $600; new members, $359.50; other sources, $2,049.30. Expenditures in 1894, $3,242.72: premiums and gratuities paid, $907.75; current running expenses, $1,108.15; other expenses, $1,226.82. The society offered in premiums $1,523.80, awarded in premiums and gratuities $1,073 and paid $907.75, which went to 19 cities and towns. Two hundred and one persons received premiums and 22 gratuities. Under head of farm and pet stock $664.50 was awarded and $616.50 paid; under head of field and experimental crops $43 was awarded and $5 paid; under farm and garden products $211.25 was awarded and $189 paid; under dairy products $22 was awarded and $21 paid; under domestic manufactures $55.75 was awarded and $36.25 paid; under agricultural implements $18 was awarded and $13 paid; under trotting $498.75 was awarded and paid; under objects other than agricultural, not specified, $48.50 was awarded and $27 paid. The society reports 1,005 members, — 755 males and 250 females. Three farmers' institutes were held: at Northampton, January 3, on "Proper care and training of children;" at Northampton, January 25, on "Composition and food value of milk" and "A talk on cooking;" and at Easthampton, March 22, on "The relation of infectious diseases to the milk supply" and "Manures and fertilizers and their use."

HIGHLAND AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 145.

Originally raised by contribution $3,262: now has $3,150 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $3,152.58: real estate, $3,000; crockery, tables, etc., $150; cash on hand, $2.58. Liabilities consist of outstanding bills to the amount of $10. Receipts in 1894, $1,421.41: bounty, $600; new members, $14; other sources, $807.41. Expenditures in 1894, $1,418.83: premiums and gratuities paid, $641.90; current running expenses, $774.43; interest, $2.50. The society offered in premiums $807.80, and awarded and paid in premiums and gratuities $641.90, which went to 20 cities and towns. One hundred and fifty-four persons received premiums and 2 gratuities. Under head of farm and pet stock $395 was awarded and paid; under field and experimental crops $29 was awarded and paid; under farm and garden products $51.80 was awarded and paid; under dairy products $8.50 was awarded and paid; under domestic manufactures $76.80 was awarded and paid; under trotting $44 was awarded and paid; under objects other than agricultural, not specified, $36.80 was awarded and paid. The society reports 436 members,— 306 males and 130 females. Four farmers' institutes were held: at Becket, February 22, on "Cattle hygiene, care, housing, feeding;" at Chester, February 28, on "Work of the Dairy Bureau" and "Composition of milk;" at Middlefield, September 5, on general subjects; and at Middlefield, October 29, on "Use of the score card."

HILLSIDE AGRICULTURAL SOCIETY.

Incorporated 1883, Acts of 1883, chapter 112.

Originally raised by contribution $3,113.32: now has $5,314 invested as a capital stock in real estate, bank funds, cash, crockery, tables, etc. Total assets, $5,314: real estate, $4,124.53; bank funds, $515.30; crockery, tables, etc., $404.35; cash on hand, $269.82. Receipts in 1894, $1,452.17: bounty, $600; bank funds, $21.94; new members, $52; donations, $31.37; other sources, $746.86. Expenditures in 1894, $1,267.76: premiums paid, $691.63; current running expenses, $520.50; other expenses, $55.63. The society offered in premiums $750, awarded $723 and paid $691.63, which went to 27 cities and towns. Three hundred and thirty-three persons received premiums. Under head of farm and pet stock $427.25 was awarded and paid; under field and experimental crops $75.75 was awarded and paid; under farm and garden products $73.50 was awarded and paid; under dairy products $15 was awarded and paid; under domestic manufactures $74.70 was awarded and paid;

under agricultural implements $6.50 was awarded and paid; under objects strictly agricultural, not specified, $6.50 was awarded and paid; under trotting $25 was awarded and paid; under objects other than agricultural, not specified, $17.55 was awarded and paid. The society reports 571 members, — 548 males and 23 females. Four farmers' institutes were held: at Ashfield, February 24, on "Education" and "Taxation;" Goshen, March 17, on "Work of the Dairy Bureau" and "Tuberculosis in cattle;" at Cummington, September 25, on general subjects; and at Cummington, November 13, on "The unemployed" and "Farm labor."

HINGHAM AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 99.

Originally raised by contribution $17,406.15; now has $22,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $22,374.06: real estate, $20,000; crockery, tables, etc., $2,000; cash on hand, $374.06. Liabilities consist of mortgages or like liabilities, to the amount of $500. Receipts in 1894, $4,337.24: bounty, $600; notes, $1,200; new members, $183; donations, $147.35; other sources, $2,206.89. Expenditures in 1894, $4,449.62: premiums and gratuities paid, $714.50; current running expenses, $1,937.78; interest and notes, $1,744.85; other expenses, $52.49. The society offered in premiums $1,950.15 and awarded and paid $714.50, which went to 16 cities and towns. Seventy-five cents went to one town outside the State. One hundred and ninety-eight persons received premiums and 270 gratuities. Under head of farms $20 was awarded and paid; under farm and pet stock $323.75 was awarded and paid; under farm and garden products $142.25 was awarded and paid; under dairy products $9 was awarded and paid; under domestic manufactures $95.30 was awarded and paid; under objects other than agricultural, not specified, $35.35 was awarded and paid. The society reports 752 members, — 540 males and 212 females. Four farmers' institutes were held at Hingham:

January 26, on "Judging by scales of points;" April 24, on "Judging by scales of points;" August 13, on "Farming implements," "Potato culture," "Varieties of fruits and vegetables" and "Profitable crops for this vicinity;" and September 17, on "Guarding crops against drought" and "Wire-worms killing strawberry plants."

HOOSAC VALLEY AGRICULTURAL SOCIETY.

Incorporated 1860, Acts of 1860, chapter 56.

Originally raised by contribution $2,006; now has $15,450 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $15,635.55: real estate, $15,000; crockery, tables, etc., $450; cash on hand, $185.55. Total liabilities consist of a bank note for $2,600. Receipts in 1894, $6,972.50: bounty, 600; new members, $115; other sources, $6,257.50. Expenditures in 1894, $6,972.50: premiums paid, $2,565.92; current running expenses, $2,350.05; interest, $51; permanent improvements, $2,005.53. The society offered in premiums $3,585 and awarded and paid $2,565.92, which went to 15 cities and towns. One hundred and twenty-two dollars went to 4 cities and towns outside the State. Two hundred and forty persons received premiums. Under head of farms $18 was awarded and paid; under farm and pet stock $500.50 was awarded and paid; under field and experimental crops $163 was awarded and paid; under farm and garden products $144.25 was awarded and paid; under dairy products $22 was awarded and paid; under domestic manufactures $210 was awarded and paid; under agricultural implements $20 was awarded and paid; under objects strictly agricultural, not specified, $35.50 was awarded and paid; under trotting $1,232.50 was awarded and paid; under objects other than agricultural, not specified, $68 was awarded and paid. The society reports 964 members, — 949 males and 15 females. Three farmers' institutes were held: at Cheshire, March 16, on "The prospective dairyman" and "Milk values;" at Williamstown, November 30, on "Profitable cattle foods;" and at Cheshire, December 28, on "Dairy feeding."

HOUSATONIC AGRICULTURAL SOCIETY.

Incorporated 1848, Acts of 1848, chapter 101.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $6,335.33; now has $14,336.15 invested as a capital stock in real estate, stocks and bank funds. Total assets, $15,022.28: real estate, $12,500; stocks, $1,000; bank funds, $836.15; crockery, tables, etc., $150; bills due and unpaid, $145; cash on hand, $391.13. Total liabilities, $2,178.06: outstanding bills, $150; mortgages or like liabilities, $2,028.06. Receipts in 1894, $10,155.90: bounty, $600; stocks, $55; bank funds, $30.04; new members, $192; other sources, $9,278.86. Expenditures in 1894, $9,679.73: premiums paid, $2,161.35; current running expenses, $3,206.51; other expenses, $4,311.87. The society offered in premiums $2,347.50, awarded $2,193.85 and paid $2,161.35, which went to 26 cities and towns. One thousand one hundred and fifty dollars and sixty-three cents in trotting purses went to 6 cities and towns outside the State. About 425 persons received premiums. Under head of farm and pet stock $1,034.50 was awarded and $1,023.50 paid; under field and experimental crops $236 was awarded and $228 paid; under farm and garden products $282 was awarded and $277 paid; under dairy products $42 was awarded and $41.50 paid; under domestic manufactures $364.50 was awarded and $360 paid; under trotting $1,722.50 was awarded and paid; under objects other than agricultural, including sports, $175 was awarded and paid. The society reports 1,536 members, — 1,487 males and 49 females. Three farmers' institutes were held at Great Barrington: February 1, on "Obstacles to successful farming;" March 8, "Cattle hygiene, housing, care and feeding;" and December 6, on "Dairying."

MARSHFIELD AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 116.

Originally raised by contribution $3,755.43; now has $22,980.08 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $22,994.39: real estate, $21,472.78; crockery, tables, etc., $1,507.30; cash on hand, $14.31. Total liabilities, $5,872.80: premiums due and unpaid, $84; outstanding bills, $18.50; mortgages or like liabilities, $5,770.30. Receipts in 1894, $4,220.63: bounty, $600; new members, $255; donations, $100; other sources, $3,265.63. Expenditures in 1894, $4,206.32: premiums and gratuities paid, $1,169.04; current running expenses, $900.28; interest, $387; other expenses, $1,750. The society offered in premiums $1,609.65, awarded in premiums and gratuities $1,208.19 and paid $1,124.97, which went to 31 cities and towns. Four dollars and twenty-five cents went to four cities and towns outside the State. Eighty-three persons received premiums and 302 gratuities. Under head of farms $20 was awarded; under farm and pet stock $179.40 was awarded and $150.50 paid; under field and experimental crops $5 was awarded and paid; under farm and garden products $166.85 was awarded and $134.50 paid; under dairy products $16 was awarded and paid; under domestic manufactures $123.54 was awarded and $123.12 paid; under trotting $650 was awarded and paid; under objects other than agricultural, not specified, $47.40 was awarded and $45.45 paid. Diplomas were awarded for agricultural implements. The society reports 902 members, — 582 males and 320 females. Three farmers' institutes were held at Marshfield: January 18, on "Dairying;" February 15, on "The perfect road horse;" March 31, on "Cooking."

MARTHA'S VINEYARD AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 33.

Originally raised by contribution $4,552.17; now has $4,201.70 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, $4,264.96: real estate, $2,750; notes, $550; bank funds, $701.70; crockery, tables, etc., $200; bills due and unpaid, $28; cash on hand, $35.26. Total liabilities, $20.82: premiums due and unpaid, $17; outstanding bills, $3.82. Receipts in 1894, $1,134.35: bounty, $600; notes, $36.50; bank funds,

$25.99; new members, $20; donations, $1.30; other sources, $450.56. Expenditures in 1894, $1,017.71: premiums and gratuities paid, $632.53; current running expenses, $230.84; other expenses, $154.34. The society offered $861 in premiums, awarded in premiums and gratuities $649.53 and paid $632.53, which went to 6 towns. Fifty-nine persons received premiums and 166 gratuities. Under head of farms $3 was awarded and paid; under farm and pet stock $238.50 was awarded and paid; under field and experimental crops, $55.50 was awarded and paid; under farm and garden products $113.17 was awarded and paid; under dairy products $13.25 was awarded and paid; under domestic manufactures $146.36 was awarded and paid; under objects other than agricultural, not specified, $82.79 was awarded and paid. The society reports 207 members, — 118 males and 89 females. Three farmers' institutes were held at West Tisbury: February 22, on "The tariff as it affects farmers;" September 19, on "Milch cows and their treatment;" and November 9, on "Which is the more profitable crop, hay or potatoes?"

MASSACHUSETTS HORTICULTURAL SOCIETY.

Incorporated 1829, Acts of 1829, chapter 22.

The first investment was from surplus Jan. 16, 1835, and amounted to $525. The society now has $247,000 invested as a capital stock in real estate, furniture, bonds and library. Total assets, $328,621.35: real estate, $250,000; bonds, $22,190; bank funds, $6,966.71; crockery, tables, etc., $40,568.98; bills due and unpaid, $2,320.48; cash on hand, $6,575.18. Total liabilities, $8,900: premiums due and unpaid, $7,900; mortgages or like liabilities, $1,000. Receipts in 1894, $30,382.47: bounty, $600; bonds, $1,117.50; bank funds, $121.66; new members, $740; donations, $26; other sources, $27,777.31. Expenditures in 1894, $24,766.81: premiums and gratuities paid, $7,207.03; current running expenses, $15,352.21; interest, $35; other expenses, $2,172.57. The society offered in premiums $7,850, awarded in premiums and gratuities $7,282.03 and paid $7,207.03*, which went to 72 cities and towns. Ninety-six dollars and fifty cents went to 8 cities and towns outside the State. One hundred and ninety-five* persons received premiums and 136* gratuities. Under head of farms $570 was awarded and $455 paid; under farm and garden products $7,195 was awarded and $6,839.33 paid. The society reports 799 members, — 744 males and 55 females. Thirteen farmers' institutes were held at Horticultural Hall, Boston: January 13, on "Fungi;" January 20, on "Pruning;" January 27, on "Grape culture;" February 3, on "Electricity and vegetation;" February 10, on "The construction and value of greenhouses;" February 17, on "A talk about mushrooms;" February 24, on "Cinerarias and calceolarias;" March 3, on "Injurious insects;" March 10, on "Metropolitan park systems;" March 17, on "Mercantile seed raising;" March 24, on "Forcing;" and March 31, on "Ornamental horticulture at the Columbian Exposition."

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* Awarded in 1893.

MASSACHUSETTS SOCIETY FOR PROMOTING AGRICULTURE.

Incorporated 1792, Acts of 1792, chapter 33.

This society made no returns to the secretary of the Board of Agriculture for the year 1894.

MIDDLESEX NORTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 315.

Originally raised by contribution $3,000; now has $35,000 invested as a capital stock in real estate. Total assets, $35-432: real estate, $35,000; crockery, tables, etc., $400: bills due and unpaid, $20; cash on hand, $12. Total liabilities, $3,700.21: premiums due and unpaid, $134.80; outstanding bills, $65.41; mortgages or like liabilities, $3,500. Receipts in 1894, $4,941.13: bounty, $600; new members, $14; other sources, $4,327.13. Expenditures in 1894, $2,-997.69: premiums and gratuities paid, $666.50; current running expenses, $1,521; interest, $175; other expenses, $635.19. The society offered in premiums $1,247.50, awarded in premiums and gratuities $801.30 and paid

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* Not including school gardeners, etc.

$666.50, which went to 12 cities and towns. One hundred and sixty-seven persons received premiums and 93 gratuities. Under head of farm and pet stock $391.70 was awarded; under farm and garden products $398 was awarded; under domestic manufactures $76.75 was awarded; under objects other than agricultural, not specified, $19.85 was awarded. Diplomas were awarded for agricultural implements. The society reports a membership of 933 males. Three farmers' institutes were held: at Tyngsborough, February 2, on "Dairy farming" and "The composition of milk;" at North Billerica, March 21, on "Judging animals by scales of points;" and at Lowell, April 11, on "What we know about plant food."

MIDDLESEX SOUTH AGRICULTURAL SOCIETY.

Incorporated 1854, Acts of 1854, chapter 84.

Originally raised by contribution $3,000; now has $13,000 invested as a capital stock in real estate. Total assets, $13,200.37: real estate, $13,000; crockery, tables, etc., $200; cash on hand, $0.37. Total liabilities, $7,400: outstanding bills, $100; mortgages or like liabilities, $7,300. Receipts in 1894, $3,523.02: bounty, $600; notes, $800; new members, $224; donations, $141.50; other sources, $1,757.52. Expenditures in 1894, $3,739.36: premiums and gratuities paid, $577.40; current running expenses, $551.49; interest, $398.47; other expenses, $2,212. The society offered in premiums $1,242.85 and awarded and paid in premiums and gratuities $577.40, which went to 7 cities and towns. One hundred and twenty-five persons received premiums and 35 gratuities. Under head of farms $24 was awarded and paid; under farm and pet stock $307.75 was awarded and paid; under field and experimental crops $50 was awarded and paid; under farm and garden products $130.15 was awarded and paid; under domestic manufactures $34.25 was awarded and paid; under objects strictly agricultural, not specified, $26 was awarded and paid; under trotting $600 was awarded and paid; under objects other than agricultural, not specified, $6.25 was awarded and paid. The society reports 584 members,—387 males and 197 females.

Three farmers' institutes were held: at Sherborn, February 1, and at Framingham, February 21, on "How to improve New England farms;" and at Holliston, February 12, on "Practical poultry culture."

NANTUCKET AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 25.

Originally raised by contribution $3,500; now has $3,200 invested as a capital stock in real estate. Total assets, $3,222.27: real estate, $3,200; cash on hand, $22.27. Total liabilities consist of premiums due and unpaid to the amount of $1.75. Receipts in 1894, $1,330.30: bounty, $600; new members, $21; donations, $3; other sources, $706.30. Expenditures in 1894, $614.25: premiums and gratuities paid, $614.25. The society offered in premiums $1,175, awarded in premiums and gratuities $616 and paid $614.25, which went to 1 town. Two hundred and nine persons received premiums and 143 gratuities. Under head of farms $10 was awarded and paid; under farm and pet stock $323.50 was awarded and $321.75 paid; under field and experimental crops $3 was awarded and paid; under farm and garden products $89.75 was awarded and paid; under dairy products $5.50 was awarded and paid; under domestic manufactures $74.50 was awarded and paid; under trotting $48 was awarded and paid; under objects other than agricultural, not specified, $60.75 was awarded and paid. The society reports 522 members, — 209 males and 313 females. Five farmers' institutes were held at Nantucket: November 3, on "Sheep raising and its profits;" November 10, on "Improvement of agricultural fair grounds;" November 12, on "Cranberry culture;" November 17, on "Poultry keeping and its profits;" and November 24, on "Good roads; their benefits to farmers."

OXFORD AGRICULTURAL SOCIETY.

Incorporated 1888, Acts of 1888, chapter 93.

Originally raised by contribution $4,400; now has $7,782.71 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $7,782.71: real estate, $7,500; crockery, tables, etc., $200; cash on hand, $82.71. Total liabilities consist of mortgages or like liabilities, to the amount of $500. Receipts in 1894, $3,068.83: bounty, $600; new members, $21; donations, $77.87; other sources, $2,369.96. Expenditures, in 1894, $2,986 12: premiums and gratuities paid, $1,179.15; current running expenses, $600; interest, $37.50; other expenses, $1,169.47. The society offered in premiums $1,700; awarded in premiums and gratuities $1,210.75 and paid $1,179.15, which went to 13 cities and towns. One hundred and thirty-two persons received premiums and gratuities. Under head of farms $46 was awarded and paid; under farm and pet stock $547 was awarded and $524.41 paid; under field and experimental crops $48.25 was awarded and $46.50 paid; under farm and garden products $23.50 was awarded and $22.19 paid; under dairy products $4 was awarded and paid; under domestic manufactures $38 was awarded and $34.42 paid; under agricultural implements $3 was awarded and paid; under trotting $480 was awarded and paid; under objects other than agricultural, not specified, $21 was awarded and $18.63 paid. The society reports 630 members, — 339 males and 291 females. Three farmers' institutes were held: at Oxford, April 12, on "Poultry culture;" at Webster, May 12 and December 14, on "The horse and its diseases."

PLYMOUTH COUNTY AGRICULTURAL SOCIETY.

Incorporated as the Agricultural Society in the county of Plymouth, 1819. Acts of 1819, chapter 2; name changed to Plymouth County Agricultural Society in 1870, Acts of 1870, chapter 251.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $9,550; now has $35,304.14 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $35,304.14: real estate, $35,000; crockery, tables, etc., $200; bills due and unpaid, $100; cash on hand, $4.14. Total liabilities, $3,893.16: outstanding bills, $293.16; notes, $3,600. Receipts in 1894, $13,060.05: bounty, $600; new members,

$19; donations, $71.15; other sources, $12,369.90. Expenditures in 1894, $13,055.91: premiums and gratuities paid, $3,340.70; current running expenses, $2,738.34; interest, $176.87; other expenses, $6,800. The society offered in premiums $4,062.50, and awarded and paid in premiums and gratuities $3,340.70, which went to 38 cities and towns. Forty-five dollars went to one city outside the State. Three hundred and fifty-eight persons received premiums and 68 gratuities. Under head of farms $47 was awarded and paid; under farm and pet stock $746 was awarded and paid; under field and experimental crops $14 was awarded and paid; under farm and garden products $176.55 was awarded and paid; under dairy products $32 was awarded and paid; under domestic manufactures $185.70 was awarded and paid; under objects strictly agricultural, not specified, $35 was awarded and paid; under trotting $2,040 was awarded and paid; under objects other than agricultural, not specified, $65 was awarded and paid. The society reports 1,600 members, — 940 males and 660 females. Three farmers' institutes were held: at Middleborough, February 23, on "Peach culture" and "Small fruits;" at Middleborough, March 23, on "Judging by scales of points;" and at Bridgewater, December 18, on "Tuberculosis in its relation to the State Cattle Commission."

SPENCER FARMERS' AND MECHANICS' ASSOCIATION.

Incorporated 1888, Acts of 1888, chapter 87.

Originally raised by contribution $4,034.08; now has $7,950 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $8,099.86: real estate, $7,150; crockery, tables, etc., $800; cash on hand, $149.86. Total liabilities consist of mortgages or like liabilities, to the amount of $1,500. Receipts in 1894, $3,401.30: bounty, $600; new members, $52; donations, $500; other sources, $2,249.30. Expenditures in 1894, $3.281.74: premiums and gratuities paid, $1,792.38; current running expenses, $1,024.21; interest, $67.50; other expenses, $397.65. The society offered in premiums $2,500, awarded in premiums and gratuities $1,837.89 and paid $1,792.38, which went to 23 cities and towns. Twenty-five dollars went to 1 city outside the State. One hundred and sixty-four persons received premiums and 88 gratuities. Under head of farms $56 was awarded and paid; under farm and pet stock $824.50 was awarded and $818.50 paid; under field and experimental crops $34.25 was awarded and $32.50 paid; under farm and garden products $66 was awarded and $62.75 paid; under dairy products $11 was awarded and paid; under domestic manufactures $72 was awarded and $67.49 paid; under trotting $767.50 was awarded and $744.14 paid. The society reports 1,009 members, — 576 males and 433 females. Three farmers' institutes were held: at Oakham, January 26, on "How to improve New England farms" and "Judging by scales of points;" at Spencer, February 13, on "Dairy progress" and "Seeds;" and at Spencer, February 21, on "Fruit" and "The farmer as a citizen."

UNION AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 110.

Originally raised by contribution $4,447.23: now has $9,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $9,181.66: real estate, $8,000; crockery, tables, etc., $1,000; cash on hand, $181.66. Total liabilities, $2,247.04: premiums due and unpaid, $97.04; mortgages or like liabilities, $2,150. Receipts in 1894, $2,634.21: bounty, $600; new members, $177; other sources, $2,457.21. Expenditures in 1894, $2,452.55: premiums and gratuities paid, $1,146.66; current running expenses, $747.79; interest, $112.50; other expenses, $443.60. The society offered in premiums $1,817.55, awarded in premiums and gratuities $1,245.70 and paid $1,148.66, which went to 26 cities and towns. Fifty cents went to 1 town outside the State. One hundred and eighty-eight persons received premiums and 95 gratuities. Under head of farms $9.50 was awarded and $5.50 paid; under farm and pet stock $536 was awarded and $511 paid; under field and experimental crops $27.50 was awarded and paid; under farm and garden products $47.75 was awarded and $43.51 paid; under dairy products $13 was awarded and paid; under domestic manufactures $93.10 was awarded and $82.17 paid; under objects strictly agricultural, not specified, $104 was awarded and paid; under trotting $365 was awarded and paid; under objects other than agricultural, not specified, $29 10 was awarded and $25.10 paid. The society reports 1,237 members, — 574 males and 663 females. Three farmers' institutes were held at Blandford: March 15, on "Better education needed for the farmer, and a habit of observation;" April 18, on "Fertilizers *v.* stable manures;" and December 19, on "General report on the public winter meeting of the State Board of Agriculture at Newburyport."

WEYMOUTH AGRICULTURAL AND INDUSTRIAL SOCIETY.

Incorporated 1891, Acts of 1891, chapter 77.

Amount originally raised by contribution had increased in 1891 to $10,270, invested as a capital stock in real estate, crockery, tables, etc. Total assets, $10,368.70: real estate, $10,000; crockery, tables, etc., $270; cash on hand, $98.70. Total liabilities, $2,964: outstanding bills, $64; mortgages or like liabilities, $2,900. Receipts in 1894, $4,320.51: bounty, $600; new members, $10; donations, $45; other sources, $3,665.51. Expenditures in 1894, $4,811.58: premiums and gratuities paid, $678.20; current running expenses, $2,399.62; interest, $167.01; other expenses, $1,566.75. The society offered in premiums $811.50, awarded in premiums and gratuities $757.65 and paid $678.20, which went to 25 cities and towns. Nine dollars and fifty-five cents went to 1 city and 1 town outside the State. Under head of farm and pet stock $433.65 was awarded and $373.65 paid; under farm and garden products $134 60 was awarded and $122.30 paid; under dairy products $4 was awarded and paid; under domestic manufactures $137.50 was awarded and $130.55 paid; under objects other than agricultural, not specified, $47.90 was awarded and $47.70 paid. The society reports 428 members, — 419 males and 9 females. Three farmers' institutes were held: at South Weymouth, January 23, on "Milk and its production;" at South Weymouth, February 20, on "Diseases of the horse's foot;" and at East Weymouth, March 30, on "Good roads."

WORCESTER AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 168.

The society in its first report to the Board in 1853 reported its permanent fund (par value) to be $7,730; now has $140,000 invested as a capital stock in real estate. Total assets, $140,220.89: real estate, $140,000; bank funds, $4.22; crockery, tables, etc., $200; bills due and unpaid, $16.67. Total liabilities consist of mortgages or like liabilities, to the amount of $50,000. Receipts in 1894, $22,225.31: bounty, $600; bank funds, $94.17; new members, $270; other sources, $21,261.14. Expenditures in 1894 $28.064.72: premiums paid, $9,824.75; current running expenses, $6,988.82; interest, $2,250; other expenses, $9,001.15. The society offered $11,288.50 in premiums, and awarded and paid in premiums $9,824.75, which went to 80 cities and towns. Two thousand seventy-eight dollars and fifty cents went to 23 cities and towns outside the State. Three hundred and sixteen persons received premiums. Under head of farms $129 was awarded and paid; under farm and pet stock $3,537 was awarded and paid; under field and experimental crops $145.50 was awarded and paid; under farm and garden products $720.50 was awarded and paid; under dairy products $40 was awarded and paid; under domestic manufactures $151.75 was awarded and paid; under grange exhibits $185 was awarded and paid; under trotting $4,820 was awarded and paid; under objects strictly agricultural, not specified, $96 was awarded and paid. The society reports 1,970 members, — 1,827 males and 143 females. Three farmers' institutes were held: at Worcester, February 1, on "Chicago cow feeding and its lessons" and "Small fruits;" at Holden, February 14, on "Silos and ensilage" and "Taxation and the farmer;" and at Grafton, March 15, on "Management of a dairy farm" and "The business side of fruit culture."

WORCESTER EAST AGRICULTURAL SOCIETY.

Incorporated 1890, Acts of 1890, chapter 41.

Originally raised by contribution $1,015; now has $4,670.44 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $4,670.44: real estate, $3,512; crockery, tables, etc., $242; cash on hand, $916.44. Receipts in 1894, $4,362.71: bounty, $600; bank funds, $28.88; new members, $84; donations, $156.50; other sources, $3,493.33. Expenditures in 1894, $4,738.95: premiums and gratuities paid, $1,265.55; current running expenses, $2,843.75; other expenses, $629.65. The society offered in premiums $1,500, awarded in premiums and gratuities $1,280.80 and paid $1,265.55, which went to 22 cities and towns. Two hundred and twelve persons received premiums and gratuities. Under head of farms $15 was awarded and paid; under farm and pet stock $663.75 was awarded and paid; under farm and garden products $206.05 was awarded and paid; under dairy products $79 was awarded and paid; under domestic manufactures $84 was awarded and paid; under objects strictly agricultural, not specified, $9 was awarded; under trotting $356 was awarded and paid; under objects other than agricultural, not specified, $208 was awarded and $217 paid. The society reports 654 members, — 468 males and 186 females. Three farmers' institutes were held: at Berlin, January 23, on "Judging by scales of points;" at Sterling, February 24, on "World's Fair butter exhibits, — what they teach;" and at Bolton, March 23, on "The Horse's foot and its diseases."

WORCESTER NORTH AGRICULTURAL SOCIETY.

Incorporated as the Fitchburg Agricultural Society, 1852, Acts of 1852, chapter 79; name changed to Worcester North Agricultural Society, 1853, Acts of 1853, chapter 359.

Originally raised by contribution $2,128; now has $3,900.38 invested as a capital stock in real estate, fixtures and cash. Total assets, $3,900.38: real estate, $2,500; crockery, tables, etc., $300; cash on hand, $1,100.38. Receipts in 1894, $3,235.44: bounty, $600; bank funds, $89.04; new members, $41; other sources, $2,505.40. Expenditures in

1894, $3,451.89: premiums and gratuities paid, $939.42; current running expenses, $2,512.47. The society offered no fixed sum in premiums, awarded in premiums and gratuities $1,027.70 and paid $939.42, which went to 16 cities and towns. Fifteen dollars and fifty cents went to 2 towns outside the State. Under head of farms $32 was awarded and paid; under farm and pet stock $421 was awarded and $406.75 paid; under field and experimental crops $73.50 was awarded and $59.50 paid; under farm and garden products $281 was awarded and $262.50 paid; under dairy products $6 was awarded and paid; under domestic manufactures $77 was awarded and $69.70 paid; under agricultural implements $14 was awarded and paid; under trotting $550 was awarded and paid; under objects other than agricultural, not specified, $46.50 was awarded. The society reports 790 members, — 732 males and 58 females. Five farmers' institutes were held: at Leominster, January 31, on "Dairying;" at Lunenburg, February 20, on "The business side of farming;" at Ashby, February 23, on "Practical dairying;" at Ashburnham, March 9, on "Taxation" and "Fruit: its enemies, insect and fungous;" and at Westminster, March 15, on "Corn culture."

WORCESTER NORTHWEST AGRICULTURAL AND MECHANICAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 117.

Originally raised by contribution $3,400; now has $10,053.90 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $12,053.90: real estate, $11,000; crockery, tables, etc., $400; cash on hand, $653.90. Total liabilities consist of mortgages or like liabilities, to the amount of $2,000. Receipts in 1894, $4,812.42: bounty, $600; new members, $87.50; other sources, $4,124.92. Expenditures in 1894, $4,856.58: premiums paid, $2,026.67; current running expenses, $2,177.59; interest, $110; other expenses, $542.32. The society offered in premiums $2,743.25, awarded in premiums $2,060.30 and paid $2,026.67, which went to 29 cities and towns. Forty-six dollars went to 3 cities and towns outside the State. One hundred and ninety-seven persons received premiums. Under head of farms $28 was awarded and paid; under farm and pet stock $801.25 was awarded and $793.39 paid; under farm and garden products $137.75 was awarded and $135.08 paid; under dairy products $22 was awarded and paid; under domestic manufactures $61.65 was awarded and $50.70 paid; under agricultural implements $5 was awarded and paid; under trotting $947.50 was awarded and paid; under objects other than agricultural, not specified, $57.15 was awarded and $45 paid. The society reports 897 members, — 607 males and 290 females. Three farmers' institutes were held: at Gardner, January 12, on "Equal taxation" and "Dairy stock; its breeding and feeding for the production of milk and the retail selling of the same;" Athol, February 2, on "The cultivation of Indian corn" and "The cultivation of the grasses;" and at Petersham, February 9, on "The management of a dairy farm" and "The construction of dairy barns."

WORCESTER SOUTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, Chapter 278.

Originally raised by contribution $3,127.40; now has $8,500 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $8,622.12: real estate, $8,000; crockery, tables, etc., $500; cash on hand, $122.12. Total liabilities, $948.75: premiums due and unpaid, $48.75; mortgages or like liabilities, $900. Receipts in 1894, $3,137.73: bounty, $600; new members, $51; other sources, $2,486.73. Expenditures in 1894, $3,216.51: premiums and gratuities paid, $1,640.50; current running expenses, $1,439.01; interest, $45; other expenses, $92. The society offered in premiums $2,200, awarded in premiums and gratuities $1,689.25 and paid $1,640.50, which went to 19 cities and towns. One hundred and thirty persons received premiums and 56 gratuities. Under head of farms $74 was awarded and paid; under farm and pet stock $727.50 was awarded and $687.50 paid; under farm and garden products $130.20 was awarded and $121.20 paid; under dairy products $28 was awarded and paid; under domestic manufactures $116.25 was awarded and $106 paid; under agricultural implements $19.50 was awarded and paid; under objects strictly agricultural, not specified, $57.50 was awarded and paid; under trotting $505 was awarded and $470 paid; under objects other than agricultural, not specified, $31.80 was awarded and paid. The society reports 1,813 members, — 933 males and 880 females. Four farmers' institutes were held: at West Brookfield, January 17, on "The management of a dairy farm" and "The composition and food value of milk;" at Charlton, February 16, on "Feeding cows for milk" and "Seeds and plant growth;" at Sturbridge, March 22, on "Judging animals by scales of points;" and at Sturbridge, April 18, on "Care of orchards and treatment of insects and fungous growths injurious to forest trees."

WORCESTER COUNTY WEST AGRICULTURAL SOCIETY.

Incorporated 1851, Acts of 1851, chapter 278.

Originally raised by contribution $3,175; now has $13,600 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $13,673.04: real estate, $12,600; crockery, tables, etc., $1,000; cash on hand, $73.04. Total liabilities consist of notes to the amount of $1,400. Receipts in 1894, $2,519.13: bounty, $600; donations, $17; other sources, $1,902.13. Expenditures in 1894, $2,495.25: premiums and gratuities paid, $1,465.47; current running expenses, $945.78; interest, $84. The society offered in premiums $1,740, awarded in premiums and gratuities $1,505.85 and paid $1,465.47, which went to 30 cities and towns. Two dollars and sixty-five cents went to 1 city outside the State. One hundred and ninety-seven persons received premiums and 15 gratuities. Under head of farms $35 was awarded and paid; under farm and pet stock $586.75 was awarded and $572.25 paid; under field and experimental crops $26 was awarded and $25.12 paid; under farm and garden products $86.50 was awarded and $69.30 paid; under dairy products $12 was awarded and paid; under domestic manufactures $66.30 was awarded and paid; under trotting $660 was awarded and paid; under objects other than agricultural, not specified, $44.50 was awarded and $40 paid. The society reports 534 members, — 481 males and 53 females. Three farmers' institutes were held: at Oakham, January 26, on "How to improve New England farms" and "Judging by scales of points;" at New Braintree, February 2, on "Apple culture for profit" and "Taxation from the farmer's stand-point;" and at Barre, February 23, on "Silos and ensilage" and "Dairy farming."

Summary.

	1892.	1893.	1894.
Number of societies,	*38	*38	†36
Amount held invested or well secured as a capital stock,	$757,407 44	$777,880 36	$776,486 22
Assets of societies,	838,379 45	865,247 67	868,860 56
Liabilities of societies,	118,046 24	131,085 52	142,119 01
Receipts,	222,737 17	199,461 90	186,244 37
Expenditures,	202,739 21	193,930 58	187,582 34
Bounty received from the State,	21,352 49	20,982 45	20,628 80
Current running expenses,	79,854 89	69,891 88	67,822 24
Amount of premiums offered,	78,787 46	81,022 73	81,096 42
Amount of premiums and gratuities awarded,	59,386 04	64,401 66	62,559 37
Amount of premiums and gratuities paid,	59,265 84	62,994 84	61,054 66
Amount awarded under head of farms,	1,428 00	1,425 00	1,477 50
Amount awarded under head of farm and pet stock,	21,776 95	20,905 40	22,024 70
Amount awarded under head of field and experimental crops,	1,460 00	1,138 50	1,351 25
Amount awarded under head of farm and garden products,	12,764 91	12,824 50	13,369 47
Amount awarded under head of dairy products,	616 80	572 35	592 50
Amount awarded under head of domestic manufactures,	3,833 06	3,820 33	4,031 47
Amount awarded under head of miscellaneous,	3,539 71	3,451 70	3,031 59
Amount awarded under head of trotting,	20,548 25	22,115 00	23,346 57
Number of persons receiving premiums,	7,265	8,103	7,921
Number of persons receiving gratuities,	1,746	1,597	1,908
Total male membership of the societies,	24,365	23,918	23,658
Total female membership of the societies,	7,372	6,834	7,050
Total membership of the societies,	31,747	30,752	30,708
Number of farmers' institutes held,	132	135	125

* Three held no fair.

† One held no fair.

ANNUAL MEETING

OF THE

BOARD OF AGRICULTURE

AT BOSTON.

FEBRUARY 5, 6 AND 7, 1895.

ANNUAL MEETING.

The Board met at the office of the secretary, in Boston, on Tuesday, Feb. 5, 1895, at 12 M., it being the Tuesday preceding the first Wednesday in February. In the absence of the Governor the Board was called to order by the first vice-president, Hon. JAS. S. GRINNELL.

Present: Messrs. Alger, F. H. Appleton, J. S. Appleton, Jr., Bancroft, Barton, Bourne, Bowker, Bursley, Clark, Clemence, Cook, Cruickshanks, Damon, Goessmann, Gove, Grinnell, Harwood, Hartshorn, Hersey, Horton, Kilbourn, Kimball, Lyman, Newhall, Palmer, Pratt, Reed, Rowley, Sargent, Sessions, Francis Shaw, N. W. Shaw, Stetson, Tucker, Ward, Warren, West and Wood.

The records of the special meeting of the Board at Newburyport were read and approved.

The executive committee, by Mr. Wood, chairman, reported the list of qualified members of the Board for 1895. The newly elected members are as follows: —

At large, appointed by the Governor: —
DWIGHT A. HORTON of Northampton.

Elected by the societies: —
Barnstable County, JOHN BURSLEY of West Barnstable.
Franklin County, GEO. E. TAYLOR of Shelburne.
Hampshire, Prof. WM. P. BROOKS of Amherst.
Martha's Vineyard, H. G. NORTON of West Tisbury.
Middlesex North, A. C. VARNUM of Lowell.
Oxford, W. M. WELLINGTON of Oxford.
Spencer, JOHN G. AVERY of Spencer.
Union, CURTIS M. BLAIR of Blandford.
Worcester North-west, A. D. RAYMOND of Royalston.
Worcester South, GEO. L. CLEMENCE of Southbridge.

Which report was accepted.

The report of the secretary was presented and a summary read, and by vote was accepted and placed on file.

The committee on agricultural societies, by Edmund Hersey, chairman, presented and read a report in part.

The reports of the inspectors were presented and referred to the committee on agricultural societies, with instructions to examine the reports and present such parts as it thought would be instructive to the Board, at a future session of the annual meeting.

Mr. F. H. Appleton gave notice that at the next session he would move an amendment to the by-laws, transposing numbers 5 and 6 in the order of business.

Adjourned to 2 P.M.

Board called to order by Mr. GRINNELL at 2.15 P.M.

The committee on domestic animals and sanitation, by Wm. Bancroft, chairman, reported the following resolve, with the recommendation that it be adopted by the Board: —

Resolved, That full compensation for all animals condemned by injection of tuberculin should be allowed the owners. That it is the judgment of this Board that the disease of tuberculosis is so wide-spread, and the benefits to be gained by stamping out the disease are of so great interest to all classes of the community, that the losses and expenses incurred should be borne by the whole community rather than by the single class who own the cattle, and should be paid by the State.

The report was accepted and discussed at great length.

Voted, That the resolve be adopted by the Board, and that the committee on domestic animals and sanitation, by its secretary, present the same as the position of the Board of Agriculture to the committees of the Legislature now considering the matter.

The committee on forestry, roads and roadside improvements, by Francis H. Appleton, chairman, made report, which report was accepted and adopted.

At 4.40 P.M. the Board adjourned to 9.30 A.M., Wednesday.

SECOND DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the chair.

Present: Messrs. Alger, F. H. Appleton, J. S. Appleton, Jr., Avery, Bancroft, Blair, Bourne, Brooks, Bursley, Clark, Clemence, Cook, Cruickshanks, Damon, Goessmann, Gove, Grinnell, Harwood, Hartshorn, Hersey, Horton, Kilbourn, Kimball, Lyman, Palmer, Pratt, A. D. Raymond, Reed, Sargent, Sessions, Francis Shaw, N. W. Shaw, Stetson, Taylor, Tucker, Ward, Wellington and Wood.

The committee on agricultural societies completed the reading of its report, which was accepted.

Voted, That the schedule of duties of inspectors recommended by the committee be adopted, as follows: —

Duties of Inspectors.

Each inspector shall visit the society to which he may be assigned, observe the methods, character and extent of its exhibition, inspect the property of the society, and make report with suggestions and recommendations concerning the society to the Secretary of the Board. (By-laws of the Massachusetts State Board of Agriculture.)

Before visiting the societies to which they are assigned, inspectors should make themselves familiar with the statute laws relating to agricultural societies receiving a bounty from the State, also with the regulations of the Board of Agriculture concerning the action of societies; these are all published in pamphlet form, and can be obtained of the secretary of the Board; they are also printed in the "Agriculture of Massachusetts" for the year 1893.

The inspector should be present at the exhibition in time to examine the cattle, and remain long enough to carefully examine all departments. He should notice if the cattle are arranged as to breed, age and class, so as to be convenient for examination by the public as well as the judges; notice if they are properly treated, well provided for, and kept on the grounds long enough to give the judges time to properly examine them.

Ascertain if the money offered for amusement, including trotting, is in proper proportion to that offered in other departments, and whether premiums offered for blooded stock are awarded to pedigree stock only.

Notice the ploughing and drawing match, and if the cattle or horses are overloaded or cruelly treated. Notice also if the exhibits in the hall are properly displayed, and arranged in a manner to aid the judges and the public in the examination of the same, and if the fruits and vegetables are properly named, with the names written or printed so as to be easily read by visitors.

Ascertain the admission fee for members and the public, number of days the exhibition occupies, division of exercises and exhibitions; and, if there are special evening exhibits or exercises, of what character they are; whether the laws of the State and the rules of the Board are complied with in every department of the exhibition, particularly in regard to offer, manner of award and designation of articles receiving premiums; whether the officers are attentive to duty, and courteous.

Plan of the society's dinner, if any; suggestions for improvement, if thought desirable.

Notice if the exhibition is educational as a whole; if exhibitions or side shows are permitted that are of an objectionable character, and if prizes are offered for the same.

Observe the fulness of the various classes of live stock; also the amount of fruit and vegetables, considering the locality and the territory which the society covers; the proportion of collections from societies, clubs, granges and individuals, and their effect upon the success and value of the exhibition; whether the number and quality of exhibits are a fair representation of the agricultural and other productive industries of the territory covered by the society; what proportion of the stock and hall exhibits come from outside the limits of the society; whether there are exhibits, and to what extent, from those who make a business of preparing exhibits of live stock and other things for a round of fairs, as a money-making scheme, and whether the society solicits such exhibits.

Convenience and adaptability of grounds, buildings, etc., for the purpose of holding a fair, and for the convenience, safety and comfort of the public of both sexes. Condition of the buildings, fences and grounds. Condition of the property of the society, and its fair value above the debts of the society.

It is not expected that the inspector will embrace in his report information on all the points to which his attention is called; but all should be observed and criticised, if criticism is needed, or commended when especially deserving.

It is the opinion of the Board that it is not good taste for inspectors to report the names of exhibitors.

Suggestions for improvement in any department of the exhibition are especially desired.

The Board requires that the inspector's report shall be filed with the secretary of the Board within two weeks after the close of the fair he has visited.

Voted, That copies of duties of inspectors and changes made in by-laws and rules of the Board be printed, and a copy sent to the secretary of each society, and also to each inspector.

At 10.30 A.M. the Board adjourned to 2 P.M., to enable the members to attend the hearing on tuberculosis before the committees of the Legislature.

The Board was called to order at 2 P.M., Mr. GRINNELL in the chair.

The recommendation of the committee on agricultural societies, regarding town farms, that no action be taken, was adopted.

The recommendation that no amendment of Rule 12 is necessary was adopted.

The recommendation that Rule 14 be not repealed was adopted.

The recommendation that Rule 14 be amended by adding, "societies are requested to print in lists of premiums offered the requirements of the Board regarding entries, exhibits and premiums," was adopted.

The recommendation in regard to the use of scales of points that no change be made, was adopted.

The recommendation that Rule 5 be amended by striking out in the sixth line the words "together with a statement of which premiums have been paid from the State bounty," and that there be added to the same rule the words "and all societies shall file with the secretary of the Board of Agriculture, on or before January 10, ten copies of their printed transactions, and shall also seasonably file with the secretary ten copies of printed premium lists and other printed documents issued by the societies," was adopted.

The recommendation that Article 12 of the By-laws, regarding duties of inspectors, be amended by inserting after the word "Board" in the ninth line the words "within two weeks of the closing day of the fair inspected," was adopted.

The recommendation that the request of the Nantucket Agricultural Society that the date of commencing its fair be changed to the Wednesday next preceding the first Monday in September be granted, was adopted.

The recommendation that the request of the Plymouth County Agricultural Society, that the date of commencement of its fair be changed to the first Thursday after the first Monday in September be granted, was adopted.

The recommendation that the date of commencement of the fair of the Hampshire, Franklin and Hampden Agricultural Society be changed to the fifth Wednesday after the first Monday in September, was adopted.

The committee on Dairy Bureau and agricultural products, by Mr. Hartshorn, chairman, reported that the matter referred to it at the last annual meeting, in reference to exhibitions of oleomargarine at fairs, had been considered by the committee, and that the committee recommended the adoption by the Board of the following: —

Resolved, That the State Board of Agriculture views with disfavor the exhibition at fairs of the incorporated agricultural societies, whether for premium or otherwise, of products the sale of which is forbidden by the laws of the Commonwealth.

The Resolve was adopted.

The report of the committee on experiments and station work was presented, read by the secretary and adopted.

The report of the committee on Agricultural College and education was read by Mr. J. E. Kimball, and was, by vote of the Board, accepted and adopted as the report of the Board to the Legislature.

The committee on agricultural societies, to which was referred the reports of the inspectors, reported that it had examined all of the reports, and that certain items of several reports seemed to it to be of interest and value, which items were read, and the reports under the rule were directed to be sent to the several societies, to be printed in their transactions or the local newspapers.

A resolution of the Jersey Breeders of Massachusetts, which had been received by the secretary, was read, as follows: —

Whereas, Jerseys registered in the American Jersey Cattle Club Herd Register are the only ones that are recognized among Jersey breeders through the entire country and Canada as pure-bred pedigree Jerseys;

Resolved, By the Jersey Breeders of Massachusetts, in meeting convened, that it is their opinion that no Jerseys should be allowed to compete for premiums at fairs in Massachusetts unless they be registered in the American Jersey Cattle Club Herd Register, and that a copy of this resolution be forwarded to the Secretary of the State Board of Agriculture.

The matter was discussed, and it was *Voted*, that it is recommended that societies print in their premium lists what authorities in pedigrees are recognized by the societies.

Voted, On motion of Mr. F. H. Appleton, notice of which motion was given yesterday, that the By-laws be amended by transposing numbers 5 and 6 of the order of business.

Election of officers being in order, ballots were taken, and the election resulted as follows: —

President, His Excellency the Governor, *ex officio*.
First vice-president, JAMES S. GRINNELL of Greenfield.
Second vice-president, FRANCIS H. APPLETON of Peabody.
Secretary, WILLIAM R. SESSIONS of Hampden.
Member Board of Control of State Agricultural Experiment Station, GEO. L. CLEMENCE of Southbridge.

Voted, That a committee of three be nominated by the chair to report names for experts.

The committee reported names, and, ballots being taken, the following elections resulted: —

Chemist, Dr. C. A. GOESSMANN of Amherst.
Entomologist, Prof. C. H. FERNALD of Amherst.

Botanist and Pomologist, Prof. S. T. MAYNARD of Amherst.
Veterinarian, Prof. JAMES B. PAIGE of Amherst.
Engineer, WM. WHEELER of Concord.
Ornithologist, E. H. FORBUSH of Malden.

The chairman announced the following standing committees (the secretary is by rule of the Board a member *ex officio* of each of the standing committees): —

Executive committee: Messrs. E. W. Wood of West Newton, W. A. Kilbourn of South Lancaster, Wm. Bancroft of Chesterfield, C. L. Hartshorn of Worcester, A. C. Varnum of Lowell, W. P. Brooks of Amherst and Francis H. Appleton of Peabody.

Committee on agricultural societies: Messrs. W. A. Kilbourn of South Lancaster, Q. L. Reed of South Weymouth, N. W. Shaw of North Raynham, F. E. Clark of Wilbraham and W. H. Gove of Williamstown.

Committee on domestic animals and sanitation: Messrs. Wm. Bancroft of Chesterfield, Isaac Damon of Wayland, W. M. Tucker of Monson, G. E. Taylor of Shelburne and Francis Shaw of Wayland.

Committee on gypsy moth, insects and birds: Messrs E. W. Wood of West Newton, Augustus Pratt of North Middleborough, F. W. Sargent of Amesbury, S. S. Stetson of Lakeville and J. G. Avery of Spencer.

Committee on Dairy Bureau and agricultural products: Messrs. C. L. Hartshorn of Worcester, D. A. Horton of Northampton, Geo. L. Clemence of Southbridge, F. A. Palmer of Stockbridge and C. B. Lyman of Southampton.

Committee on Agricultural College and education: Messrs. A. C. Varnum of Lowell, Geo. Cruickshanks of Fitchburg, E. A. Harwood of North Brookfield, John Bursley of West Barnstable and A. D. Raymond of Royalston.

Committee on experiments and station work: Messrs. W. P. Brooks of Amherst, C. L. Hartshorn of Worcester, Geo. L. Clemence of Southbridge, C. E. Ward of Buckland and H. A. Cook of Northbridge.

Committee on forestry, roads and roadside improvements: Messrs. Francis H. Appleton of Peabody, J. H. Bourne of Marshfield, Isaac Alger of Attleborough, S. M. Raymond of Hinsdale and J. S. Appleton, Jr., of Nantucket.

The committee on agricultural societies, by Mr. Kilbourn, chairman, reported the following assignment of inspectors:

Amesbury and Salisbury, at Amesbury, September 24, 25 and 26,	Isaac Alger.
Attleborough, at Attleborough, October 1, 2 and 3,	Geo. L. Clemence.
Barnstable County at Barnstable, September 10, 11 and 12,	F. E. Clark.
Berkshire, at Pittsfield, September 10, 11 and 12,	N. W. Shaw.
Blackstone Valley, at Uxbridge, September 24 and 25,	Geo. Cruickshanks.
Bristol County, at Taunton, September 24, 25 and 26,	F. H. Appleton.
Deerfield Valley, at Charlemont, September 12 and 13,	A. D. Raymond.
Eastern Hampden, at Palmer, September 17 and 18,	E A. Harwood.
Essex, at Haverhill, September 17, 18 and 19,	C. M. Blair.
Franklin County, at Greenfield, September 19 and 20,	W. A. Kilbourn.
Hampden, at Springfield, September 19 and 20,	F. W. Sargent.
Hampshire, at Amherst, September 24 and 25,	H. A. Barton, Jr.
Hampshire, Franklin and Hampden, at Northampton, October 2 and 3,	J. G. Avery.
Highland, at Middlefield, September 4 and 5,	Geo. E Taylor.
Hillside, at Cummington, September 24 and 25,	S. S. Stetson.
Hingham, at Hingham, September 24 and 25,	W. M. Tucker.
Hoosac Valley, at North Adams, September 17, 18 and 19,	J. H. Bourne.
Housatonic, at Great Barrington, September 25, 26 and 27,	C. B. Lyman.
Marshfield, at Marshfield, September 11, 12 and 13,	F. A. Palmer.
Martha's Vineyard, at West Tisbury, September 17 and 18,	C. E Ward.
Massachusetts Horticultural, at Boston, October, 1, 2 and 3,	J. S. Grinnell.
Middlesex North, at Lowell, September 12, 13 and 14,	W. H. Gove.
Middlesex South, at Framingham, September 10 and 11,	H. G. Norton.
Nantucket, at Nantucket, August 28 and 29,	Q. L. Reed.
Oxford, at Oxford, September 17 and 18,	E. W. Wood.
Plymouth County, at Bridgewater, September 5, 6 and 7,	Wm. Bancroft.
Spencer, at Spencer, September 19 and 20,	H. A. Cook.
Union, at Blandford, September 11, 12 and 13,	A. Pratt.
Weymouth, at South Weymouth, September 26, 27 and 28,	J. S. Appleton, Jr.

Worcester, at Worcester, September 3, 4, 5 and 6, ...	ISAAC DAMON.
Worcester East, at Lancaster, September 12 and 13, ...	W. M. WELLINGTON.
Worcester North, at Fitchburg, September 17 and 18, ...	J. BURSLEY.
Worcester North-west, at Athol, October 1 and 2, ...	C. L. HARTSHORN.
Worcester South, at Sturbridge, September 12 and 13, ...	WM. P. BROOKS.
Worcester County West, at Barre, September 26 and 27, ...	S. M. RAYMOND.

Report accepted and adopted.

At 4.45 P.M. the Board adjourned to 9 A.M., Thursday.

THIRD DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the chair.

Present: Messrs. Alger, F. H. Appleton, J. S. Appleton, Jr., Avery, Bancroft, Blair, Bourne, Brooks, Bursley, Clark, Clemence, Cook, Cruickshanks, Damon, Goessmann, Goodell, Gove, Grinnell, Harwood, Hartshorn, Hersey, Horton, Kilbourn, Lyman, Palmer, Pratt, A. D. Raymond, Reed, Sargent, Sessions, Francis Shaw, N. W. Shaw, Stetson, Taylor, Tucker, Ward, Wellington and Wood.

Voted, That the secretary cause two hundred copies of the report of the examining committee of the Agricultural College to be printed in pamphlet form for the use of the Board and the trustees of the college.

Mr. Chas. E. Ward read an essay on "Farming as an occupation," which was accepted and will be found printed in this volume.

Voted, That the thanks of the Board be given Mr. Ward for his admirable paper, and that the secretary cause one hundred and fifty copies to be printed in pamphlet form for distribution.

The records of the first two days were read and approved.

The committee on Agricultural College and Education reported, by Mr. Cruickshanks, that the next public winter meeting should be held at Dalton. The report was accepted, and the Board voted to hold the next public winter meeting at Dalton.

On motion it was *Voted*, that the invitation of the Hampshire Agricultural Society to meet at Amherst in 1896 be referred to the committee on Agricultural College and education for consideration.

A committee on essays for the next annual meeting was appointed by the Chair: Messrs. Reed, Stetson and Pratt; which committee reported, by its chairman, as follows: —

"Field crops," Prof. Wm. P. Brooks.
"Vehicles for transportation and for pleasure," F. W. Sargent.

The report was accepted and the appointments made.

Voted, That the Chair appoint a local committee of five, to act with the secretary and the committee on Agricultural College and education in arranging for the public winter meeting. Messrs. Barton, Bancroft, S. M. Raymond, Palmer and Gove were appointed.

Voted, That it be the duty of each member of the Board to visit the Agricultural College at least once during his term of office.

Voted, That the secretary be requested to secure, at such time as this Commonwealth building is torn down, a piece of wood from our front room to be made into a gavel for the use of the presiding officer, as a reminder of the pleasant relations under which the members have endeavored to serve the State.

A vote of thanks was unanimously tendered the chairman for his very acceptable services as presiding officer.

The records of the third day were read and approved.

Adjourned.

WILLIAM R. SESSIONS,
Secretary.

REPORT TO THE LEGISLATURE OF THE STATE BOARD OF AGRICULTURE, ACTING AS OVERSEERS OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

[P. S., Chap. 20, Sect. 5, adopted by the Board, Feb. 6, 1895.]

Under the By-laws, "the committee on Agricultural College and education" is "charged with the duties of the Board as Overseers of the Massachusetts Agricultural College, as provided for in chapter 20, section 5, of the Public Statutes." These duties, as prescribed by the Governor and Council, comprise not only visits to the college and attendance upon its exercises, but also an inspection of its property, observation of its instruction, with suggestions and recommendations.

It would be most fitting and quite in accordance with the wishes of your committee to preface this report by a rehearsal of those enactments by national and State legislatures which have given the college "a local habitation and a name;" those epochs in its history which mark successive triumphs over active opposition or a more baleful apathy; and indeed that wise statesmanship and those brilliant examples of individual championship which have resulted in such a heritage to the Commonwealth cannot become too familiar, and are not likely to be too often commended to our notice. But, as these historical antecedents have been repeatedly alluded to in previous reports, it is thought that in the interest of brevity they may be safely omitted, with a passing reference, however, to records accessible in "Agriculture of Massachusetts;" for the present *status* of the college can be duly appreciated only as it is viewed through the medium of its past history. The volumes for 1863, 1864, 1868–69, 1870–71, 1874–75, 1879–80, 1881, 1885, 1889 and 1890 will be found to contain much which sheds light upon the institution of to-day. In like manner and for a like reason reference is made to the annual report of the college for statistical facts and figures appertaining to its routine work and history.

To subserve the purposes for which the members of this committee were designated, they have chosen two periods for observation: first, Commencement week, in June; and, second, the middle of October, when the organization for the new collegiate year was fully complete. During both these visits every facility, as far as time would permit, has been afforded for a thorough inspection of college and experiment stations in all their departments. It is a pleasure to recognize at the outset the painstaking courtesy of President Goodell and his associates in their efforts to make the duties of the committee at once pleasant and effective.

After a faithful but far from exhaustive examination, the committee is more than ever impressed with the conviction that the citizens of the Commonwealth possess in this institution a people's college in which they may well feel an an honest pride. As we recall its early history, with its record of distrust, discouragement and struggle, the wonder grows that the intelligent citizens of Massachusetts have been so slow in according to it that recognition and patronage which it is so richly qualified to repay.

It were needless, if possible, to trace in labored detail the various lines of work and investigation which are all converging towards practical results. There is so much which appertains to technical processes, mysterious to all but experts, that a general view will be more interesting and perhaps not less instructive.

A just estimate of the success of an educational institution involves a right apprehension of its purpose and scope. The Massachusetts Agricultural College is founded and carried on not to make farmers exclusively, but to furnish such instruction and training as will enable the sons of the people, whether farmers or otherwise, to choose intelligently and exercise successfully an honorable calling without prejudice to any. That its tendency is to elevate and dignify the pursuit of agriculture goes without saying, but that its benefits do not stop there is equally evident. Its aim is to turn over to the State good citizens, fully equipped to develop its resources, and not only to conserve but to improve its institutions. In the light of this declaration the utility and value of its plant, its equipment and its curriculum will become manifest. Its spacious and well-chosen site, its fertile and richly teeming acres of orchard and meadow reclaimed from waste and abandoned swamp-land, its landscape beauties enhanced by every year's growth and improvement, its avenues bordered by shade trees, its heights and declivities adorned with sightly structures for use and beauty and some of them models of their kind, — all proclaim at once the transforming power of skilled industry and the exalted aims of the institution which here finds its seat.

Commencement week was full of activity and replete with interest.

The first duty of the committee was to attend the examination of the members of the graduating class in theoretical and practical agriculture. The written and oral test prescribed resulted in the award of the first prize to John Edwin Gifford, Brockton; and the second prize to George Henry Merwin, Westport, Conn.

The chapel exercises on Sunday, including the Baccalaureate sermon by Professor Walker and the address before the Young Men's Christian Association by Dr. Moxom, afforded a suggestive glimpse of the religious life of the college.

The prize speaking, evincing a spirit of generous and healthful competition, was highly creditable to the participants, and no less so to those who had presided over their preparation.

The festivities of Class Day present student life to the view from a new stand-point and under an aspect peculiar but not without instructive features. Beneath the exuberance of rollicking hilarity and good-natured raillery there is discernible an undercurrent of serious purpose and stanch loyalty to *Alma Mater* which is an earnest of devotion to her interests and a pledge of success.

In view of the detailed reports in previous years, it is hoped and assumed that the military department has passed that stage in which it is needful to vindicate the wisdom of its establishment or demonstrate its utility. Not to speak of its incidental benefits, manifest in every department as well as in the personal bearing of the students, certainly the field exercises of 1894 were well calculated to remove any scepticism on these points, and, by their suggestive exhibition of trained and intelligent power available in possible emergencies, to challenge admiration for the foresight of Congress in making *military tactics* an essential feature.

The twenty-fourth annual Commencement, with its theses and orations grappling intelligently and hopefully with themes most vital to the material and social interests of the Commonwealth, was a fitting conclusion to another year of successful achievement. The eloquent words of commendation, so happily phrased in the address of His Excellency the Governor, for the idea which here finds embodiment and the faithful workers who are so industriously developing this idea, found a hearty response in every listener.

The limited opportunities, during the first visit of the committee, for observing the ordinary workings of the college, were supplemented by more favorable conditions in October; and, while much more time might with profit have been employed, enough was seen to leave definite impressions.

It is a fact of interest and not without significance that upwards of fifty per cent of the instructors are graduates of the Massachusetts Agricultural College, — a suggestive commentary upon its past history and a prophecy for its future. We learn also that the record and standing of those who have sought other fields tell a similar story of competence and responsibility. Even a hurried visit to the class rooms reveals the cause. Young men come here with a purpose; it prompts to industry, earnestness and enthusiasm, which are met in turn by a kindred enthusiasm, in a spirit of helpfulness, and this seems to inspire every member and pervade all activities.

It is a pleasure to observe that in an institution where special training necessarily holds so prominent a place, those branches usually regarded as appertaining especially to *liberal culture* are not neglected. In the department of English we listened to the delivery of original productions by members of the junior class, in which were discussed with liberal breadth and commendable ability such subjects as "The relation of outside nations to the Chinese-Japanese war;" "Medical quacks;" "The destruction of American forests;" "The power of the modern newspaper;" "Independence."

The elective feature for studies of the senior year, of recent introduction, is in line with the most advanced thought in the higher education, and promises well to student and instructor in the kindling of fresh ardor and the production of better work.

The shorter course of two years, for those whose student life is limited by circumstances beyond their control, is regarded as a wise provision, and the slight falling off in numbers this year is attributed to no defect in the plan, but to exceptional causes.

But, interesting and important as the work of the class room may be, one obtains but a meagre conception of what is here going on until he steps outside and interrogates the experiment stations as to the inspiration and aim of their intense but well-directed activity; until he passes from laboratory to plant-house, from plant-house to insectary, from insectary to garden, and so on through nursery and orchard and a maze of experiment plots, and begins to grasp, imperfectly it may be, the multitude and variety of problems which here await solution, that the industrial classes, especially those concerned with agriculture, may have ready to their hand the best results of scientific research. Here the wants of animal and plant are analyzed and defined; soils are forced to yield up their secrets and confess their deficiencies; fertilizers are required to make good their professions or stand condemned; a pound of beef or pork is labelled with its minimum cost, and a recipe appended for its successful production; continents are ransacked for plants susceptible of cultivation in Massachusetts, and when found and acclimated the seed is sown broadcast throughout the State; while the enemies of beast, bird and plant are placed under examination, their pictures taken, their bodies mounted and their life-history written, including their power to hurt and their limitations.

For a succession of days, with open eyes and alert perceptive faculties, the committee has passed in and out amid the varied activities of this hive of human industry, and the question has recurred, with ever-increasing emphasis, "How can the fruits of this institution be made more available to those in whose interest they are maturing?" Whether the attention has been directed to producing and utilizing crops or to investigating the habits and history of insect pests which destroyed them, to the care and management of domestic animals in health or their treatment in disease and suffering, in field and laboratory, in museum and library, the ever-present interrogatory has been, "Do the farmers of Massachusetts know what is being done for them?"

In the attempt to inventory the resources of the institution we have seen fields — and that, be it remembered, in "sterile New England" — which, like the land of the Nile in the seven plenteous years, literally "brought forth by handfuls;" in threading devious passages of its crowded halls we have stumbled over implements of tillage representing every stage of progress from the rudest and most primitive to the latest triumph of inventive genius, and wanting only arrangement to present a complete "history of agriculture" addressed to the eye; in seeking the latest exponent of modern progress we have encountered improvements which seemed almost to elevate agriculture to a rank among the fine arts.

Of these improvements a fitting climax is reached in the new barn, just completed. Without attempt at description, which if worthy of its object might be accepted as a substitute for a personal inspection, and if inadequate were better omitted, its location upon a gentle declivity and its modest style of architecture impart an air of unobtrusiveness like that of the department which it typifies, but once beneath its all-sheltering roof it grows upon the senses and expands until in capacity and purpose it seems "as broad and general as the casing air;" and in this marvel of solid completeness and skilful adaptation, a walk through which would be to many a Massachusetts farmer a *liberal education*, agriculturally speaking, the question recurs, "How can such an object-lesson be brought within the vision of those who most need its instruction?"

To these and similar questions come two responses which offer a partial if not complete solution of the problem. The first relates to the wants of the college itself, and the second to the wants of the people whose it is, and who should profit by its beneficent influence.

It is a fact, patent to any one competent to judge, that in some directions the college is rapidly outgrowing its accommodations. The buildings, with all possible shifts in the interest of economy of space, are barely adequate to present needs, and the inconvenience of crowding must soon be painfully felt. Many of those now on the ground were constructed for the infancy of the enterprise, and should be superseded. In these days of improved educational methods, especially in the natural sciences, something more is necessary for illustration and instruction than space and shelter: museums and cabinets, in order to become available auxiliaries for educational work, must include arrangement and classification; laboratories and lecture rooms must regard facility and despatch, as well as breadth and thoroughness; close proximity in related departments makes for economy and efficiency, as well as for ease and convenience; hence we are impressed with the conviction that the time has come for these structural reminders of the day of small things to give way to a new and nobler type of architecture, adequate to the exigencies of a vigorous and growing institution, commensurate with the functions and ideals of a grand, popular mission, and worthy of the great Commonwealth which founds and fosters them.

If our academical neighbor can honor science by a temple whose ample proportions and generous appointments mark a distinct advance in this rising department, may not the State affix its seal of approval by imitating such enterprise, and so recognize by substantial homage the future handmaid of all successful agriculture? What better investment for the future of the State than a hundred thousand dollars to inaugurate a new era in the history of the Agricultural College; to focus under one roof those agencies of modern science which are making themselves felt on every farm in

Massachusetts, and are destined eventually to revolutionize the methods which have there prevailed?

Again, the Massachusetts Agricultural College should come into closer touch with the people of the Commonwealth. It is well to publish reports and issue bulletins, and they are doing much to disseminate information and stimulate a spirit of inquiry; but hundreds and thousands who would most profit thereby never see them, and in some quarters there may exist unreasonable prejudices against receiving instruction in agriculture through this medium. It must be brought home by the living voice and presence; experts must meet the people face to face, and talk familiarly about those things which deeply interest both. What better fountain for such streams of influence than the State institution at Amherst? Let them be designated as they may, — "popular," "conversational," "familiar" *lectures*, "institute work," or, more properly, as conforming to advanced methods and as boldly proclaiming the faith and policy of their source, "university extension;" professors and teachers from this centre during the farmer's winter leisure should go abroad in the Commonwealth, organizing in the cities or larger towns and in rural centres special courses of instruction suited to the needs of practical farmers, and thus create in a sense an itinerant college.

But, it is objected, this would involve the necessity of a larger teaching force and increased expenditure. Be it so. Multiplying needs and a widening field are evidences of growing intelligence and higher standards; and Massachusetts, ever in the van of educational progress, will be the last to shrink from responsibilities imposed by success, or to regard with disfavor such drafts upon her bounty.

There is another line of inquiry, no less important, and which, had time permitted, it would have been a pleasure to the committee to pursue, — that which touches more nearly the conditions immediately surrounding the students themselves. We have not been able even to visit the dormitories and inspect their appointments. There was pointed out in a retired part of the grounds a building where the students were fed. Some irreverent spirit within us has been prompting the inquiry whether the rations there furnished were prepared with the same conscientious solicitude and the like scientific precision as those for the occupants of barn and stable. We have passed and repassed the chaste and beautiful stone chapel, consecrated to purposes of devotion and worship, and found ourselves wondering whether these exercises so essential for the sustenance and vigor of the religious life were hallowed and sweetened in the memory of these young men by the associated presence of those whose interest and sympathy could for the time being beguile them into a partial forgetfulness of the absence of father and mother, brother and sister. Again and again we have enjoyed the hospitality of the professors at their homes, and as often has imagination presented these homeless students, removed from the associations of the family circle, with its encouragements and restraints. What compensation for this loss is furnished in efforts to bring to bear the mellowing influences of refined circles, so essential to social culture and symmetrical character-building?

These, with kindred queries, must be left to other observers and future reports.

Respectfully submitted,

A. C. VARNUM.
GEO. CRUICKSHANKS.
E. A. HARWOOD.
JOHN E. KIMBALL.
JOHN BURSLEY.

FARMING AS AN OCCUPATION.

BY CHAS. E. WARD OF BUCKLAND.

The history of agriculture as an occupation dates from the Garden of Eden. We read that Adam was driven from the garden to till the ground from whence he was taken. Abel was a keeper of sheep, untroubled by free wool, and Cain was a tiller of the ground. Cain, being unsuccessful, went into the land of Nod and founded a city. Farming must have been hard in those days, for we are told that the ground was cursed, and was to bring forth thorns and thistles, and its products to be eaten in sorrow. Some farmers at the present time seem to think that this curse was never removed; but we are told in Holy Writ that in the days of Noah the Lord said in his heart, "I will not again curse the ground any more for man's sake. While the earth remaineth seed time and harvest shall not cease." After the flood Noah planted a vineyard and made a bad use of its fruit. Jacob seems to have been a successful breeder of stock. I doubt if any of our modern breeders have any more shrewdness than he, for it will be remembered that when Laban promised him the ring-streaked and speckled of his flock for his labor, it was not long before all the *best* of them *were* ring-streaked and speckled. Stock raising was carried on to a much greater extent than is possible at the present time, and we read of Moab paying Israel tribute of a hundred thousand lambs and a hundred thousand rams, with the wool. Job had fourteen thousand sheep, six thousand camels, one thousand yoke of oxen and one thousand she-asses.

These old patriarchs had these advantages over farmers of the present age; they had no difficulty in keeping the boys on the farm and no fear of the tuberculosis commissioner.

The ancient Egyptians were skilful farmers. From the paintings and inscriptions upon their tombs we get an idea of the advanced condition of farming three thousand years ago. An Egyptian farm comprised all the departments which we have at the present time. There were houses with various rooms, gardens, orchards, farm yards with sheds for cattle and stables for horses. They were great raisers of poultry, and practised artificial hatching. The land was ploughed with oxen and the seed sown by ploughing and rolling in. Egypt paid Rome tribute of twenty million bushels of corn annually. Manuscript deeds were given in the time of the Ptolemies. These contained, besides a description of the land, descriptions of the buyer and seller, their personal appearance, parentage, profession and residence, and were attested by a large number of witnesses.

The early Romans were earnest farmers, and their wealth consisted in land and its products. As the farmer prospered, commerce and traffic followed, but always occupying a subordinate place. A writer says: "Perhaps it is not too much to assert that many of those qualities which fitted them for conquering the world were acquired or nourished and matured by the skill and persevering industry so needful for the intelligent and successful cultivation of the soil." Cicero puts into the mouth of Cato these words: "I come now to the pleasures of husbandry, in which I vastly delight. They are not interrupted by old age, and they seem to me to be pursuits in which a wise man's life should be spent. The earth does not rebel against authority; it never gives back but with usury what it receives. The *gains* of husbandry are not what exclusively commend it. I am charmed with the nature and productive virtues of the soil. Can those old men be called unhappy who delight in the cultivation of the soil? In my opinion there can be no happier life, not only because the tillage of the earth is salutary to all, but from the pleasure it yields. The whole establishment of a good and assiduous husbandman is stored with wealth; it abounds in pigs, in kids, in lambs, in poultry, in milk, in cheese, in honey. Nothing can be more profitable, nothing more beautiful than a well-cultivated farm." Cato speaks of irrigation, frequent tillage and manuring as a means of fertilizing the soil. Pliny writes of the practice of leaving the land fallow every second year, and says: "It is a good plan, providing the man has land enough, to give the soil this repose. But how if he has not enough? Let him in that case help himself thus: let him sow his next year's wheat crop on the field where he has just gathered his beans, vetches, lupines or such other crop as enriches the ground; for indeed, it is well known that some crops are sown for no other purpose but as food for others, — a poor practice, in my opinion."

Thus we see that in the early days of the world's history the people adopted many of the methods of the intelligent farmer of to-day. We glean but little from the history of ancient Greece, but that little points to the probability that agriculture held a valuable place in the estimation of the Grecians, and that the tiller of the soil was second to none in political importance. These were the days when farming held the foremost rank among other industries, — foremost, because it was considered first as a means of acquiring wealth, first in respectability and first in securing a peaceful society and ensuring a strong government. The ancient belief, that "no other labor is at once so good for mind and body, and so worthy of freemen," may well be ours.

From this high position farming as an occupation has fallen; and where were once productive fields and a happy peasantry, we find ill-kept farms and a people but little if any above a condition of slavery. Among the causes which led to this state of things were the many wars in which they engaged. It mattered little which nation conquered, — success and defeat were alike disastrous to the farmer. When a nation was defeated, its land was taken and its people held in slavery, and land and people were farmed out to wealthy citizens, thereby producing a competition ruinous to the free farmers of the conquering nation. Many attempts were made to remedy this evil by dividing the land among the people, but always without success, as the power of concentrated wealth was too strong to be broken. Again, the burden of taxation was heavy, the farmer, then, as now, paying more than his share. These taxes were leased to the gatherer, and the farmer's property was easily found. Farming must have been carried on under great difficulties during the middle ages, the farmer being under the protection and subjection of the feudal barons, who were often at war with each other; and if the farmer escaped the ravages of the enemy, the levies made upon him by his so-called protectors left him little for his labor.

The early history of this country is a record of agricultural industry. For many years after the landing of the Pilgrims farming was the chief occupation of the people. We have quoted a writer as saying, of the early Romans, that those qualities which fitted them for conquering the world were acquired by the skill and persevering industry so necessary to an intelligent cultivation of the soil. In a still greater degree may we attribute the wonderful growth of this country to the New England character, which was developed and matured amid hardships and trials on the old New England farms, around the old New England firesides. I believe that it was something more than accident that brought our ancestors to this land, so wonderfully adapted to the development of the spirit of liberty and progress.

While visiting the White City — the great illustration of our national prosperity — I came in contact with an enthusiastic resident of the new State of Washington, who, after describing its productive soil and enlarging on its other wondrous qualities, capped the whole with this exclamation: "Why, sir, if the Pilgrim Fathers had landed on Puget Sound instead of Plymouth harbor, they would have accomplished in fifty years all that has been done in nearly three hundred years." I admired his loyalty to his State and his enthusiasm for her greatness; but I could not forbear the remark that, in that case, with everything ready to our hand, we would more likely have remained subject to Great Britain. The struggle to become independent came after the struggle with the soil, and the victory over the stern and rock-bound coast gave them courage to encounter the stern and rock-bound king. We to-day complain of the lack of opportunity which the farmer has for growth and usefulness, but here upon the same hills and in the same valleys where we live, the farmers of Massachusetts, surrounded by savages, and neglected by the home government, which should have cherished them, were making notable history. The thought which is too prevalent to-day, that the rural farmer, because of his isolation, cannot be in touch with men of the world on all of the important questions of the day, finds no confirmation in their lives. Think of a town meeting of farmers in western Franklin, at a time when it seemed as if all they could do was to eke out a miserable existence, passing resolutions against the most powerful nation in the world, and pledging their support to resistance, even to death, to its arbitrary enactments! I suspect we would be inclined to ridicule such a meeting to-day as insignificant and puerile; but there is always significance and strength in the actions of men when animated by the determination and high purpose of the farmers of Massachusetts in the Revolutionary period.

Farming was the leading occupation in this State during the first quarter of the present century; and in 1814, Webster, in a debate in Congress upon the tariff, said: "I am not anxious to accelerate the approach of the period when the great mass of American labor shall not find its employment in the field; when the young men of the country shall be obliged to shut their eyes upon external nature, upon the heavens and the earth, and immerse themselves in close and unwholesome workshops; when they shall be obliged to shut their ears to the bleating of their own flocks upon their own hills, and to the voice of the lark that cheers them at the plough, that they may open them in dust and smoke and steam, to the perpetual whirl of spools and spindles and the grating of rasps and saws.

Webster was soon to see the period of which he spoke. For nearly two hundred years the farmer in a small way had been a manufacturer as well. The clothing which he and his family wore, and many of the utensils of the farm and house, were home made; but now there began to be dams thrown across the small as well as the large streams, and in little shops in every hamlet began that tide of manufacturing which has built the many large cities and towns in the Commonwealth, and drawn from the country much of its best life. Then, too, the Western fields began to open, and made large drafts of the sturdy men upon the old New England farms. No wonder that there can be found on many a hillside a grass-covered cellar, with perhaps a lilac or rose bush near, to tell us that here was once a farmer's home.

During the second quarter of this century the loss of population in farming districts was not great, as the manufacturing was done in small shops on the little streams, as has been stated; but the centralizing tendency had begun, and in this last half of the century the large corporations have crowded out these little shops, until now there are only traces of dams once utilized for carding, fulling, tanning and various wood-working industries.

I do not think farming as an occupation would have been greatly injured by this drift toward the manufacturing centres had it not been for the loss to rural society, not alone of population, but of active, stirring life. This so discouraged the farmer that he was too ready to belittle his calling, and to teach his children that, if they expected to do or *be* anything, they must go out into the world beyond. "Abandon all hope, ye who enter here," was virtually written over the door of many a farm-house, and from some of them the sign has not yet been taken down. I am glad to record here a belief that the discouraging tendency has ceased. I think he must be blind who cannot see that there has been a new impetus within the past few years. It is shown in more productive fields, in better-kept stock, — I am not sure but the stock has been kept too well, — in better farm buildings, and above all else in the improvement of the farmer himself. He is coming to have more of that attribute so necessary in peace or war, — courage. He is becoming — although he may not realize it — a scientific farmer.

This is a sketch of the history of farming as an occupation, and it may be well to devote the rest of this paper to its outlook for the future. As in everything else, there are conditions that tend to depress this occupation, and perhaps the hardest of these which the farmer now has to meet is unequal taxation. We have seen that in all ages this is fatal to agricultural prosperity. It is hurtful in taking too large a proportion of his hard earnings; but this is of less account than its effect upon the status of the occupation, for in choosing a vocation one naturally selects that one which is most favored in this respect.

None of the many changes of the nineteenth century are more marked than the change in values from that of real estate to *personal* property. If the taxes are fairly levied upon real and personal property alike, the farmer, whose property naturally is real estate, would stand on an equal footing with the rest of mankind. Unfortunately, this is not the case in Massachusetts. Our laws have exempted much personal property, and advantage is taken of every such exemption to evade taxes. The farm is always on exhibition; it cannot be hidden or disguised, and so its owner has not the opportunity to "dodge" his taxes, which the man rich in personal property can do and often does. And every time this is done, — whether it be done according to law or in defiance of law, — an additional burden is placed on the farm. Taxes should be levied according to our ability to pay, and not according to our ability to conceal. It is actually argued by some newspapers that all taxes should be assessed upon real estate alone, because so much deception is practised by the holders of personal property that we do not get more than one-half of it to tax anyway. These advocates of complete exemption of personal property exhibit the ingenuity of "Artemus Ward," who, upon being told by a creditor that he would throw off fifty dollars from an account of one hundred dollars, replied, "My friend, I will not be outdone by you in generosity, — I will throw off the other fifty." I do not claim that farmers are less culpable in the desire to evade taxation; but the great mass of them, whether they will or no, cannot do this, as their property is always where the assessor can "view the landscape o'er."

There are farmers who have a little more money than their neighbors, and the savings banks usually get it, because their deposits are exempted from taxation by law. I suppose it is the intention of this law to encourage small savings among the people; but there is nothing to prevent a man's having one thousand dollars in every savings bank in the Commonwealth; and, if he has a wife and children, he can make like deposits in each of their names, and all this is done simply to escape taxation.

I believe that equal taxation would be of great benefit to the farmers; it is their due, and the great wonder is that they have not risen *en masse* and demanded it. I know that it is claimed that savings bank deposits ought to be exempt, because only four per cent interest is paid; but that rule would exempt many of our farms, very few of them yielding more than that to their possessors. Half of this in many cases goes for taxes, leaving but two per cent for the farmer's investment. This is the great drawback to farming as an occupation at the present time.

A lack of faithful, intelligent farm-help is another disadvantage to the farmer. It used to be possible to obtain good, sturdy "Yankee" boys for that purpose; but that day has gone by. I recall a couplet by Benjamin Franklin which reads like this:

"He who by the plough would thrive,
Himself must either hold or drive."

If he wants a good job done now, he has to hold and drive too. The disposition of the boys to leave the farm and go to the overcrowded city is an adverse condition. I have great respect for the lad who is ambitious, and goes to the city because he seeks greater opportunities than the quiet farm life can give; but there are many who forsake the farm which needs them because they think a farmer's occupation is degrading; these need to be taught that "Honor and shame from no condition rise; act well your part, there all the honor lies." Farming, while it gives good hard work for the muscles, is an occupation in which a man can use all the brain capacity of which he is possessed.

"The man who tills the soil need not be of an earthy mind;
The digger 'mid the coal need not be in spirit blind."

I think it must be admitted that farmers are much to blame for the low opinion which so many of their children entertain of this time-honored vocation, for they are apt to eagerly speak of its worst features and forget to mention the many pleasant things that a farmer enjoys. I do not believe we can find manufacturers or merchants that would say to their boys, "I would like to have you master the business so that you can carry it along when I am unable to manage it; but it is a miserable business, and I wish that I could have been in some other occupation; there is no chance to obtain anything but a bare living, and you will have to work hard for that." It may seem an exaggeration, but I have heard *farmers* speak as discouragingly of their own occupation.

These are some of the adverse conditions of farming, but I am fully persuaded that much more can be said in favor of this occupation than has been said against it. It is absolutely necessary for the maintenance of the republic, not chiefly in its productions, which all must consume, but in the men and women who constitute that middle class which is the strength of any nation, but most of all of a republic.

> "What constitutes a State?
> Not high-raised battlements and labored mound,
> Thick wall or moated gate;
> Not cities proud, with spires and turrets crowned;
> Not bays and broad-armed ports,
> Where, laughing at the storm, proud navies ride;
> Not starred and spangled courts,
> Where low-browed baseness wafts perfumes to pride:
> No! men, high-minded men,—
> Men who their duties know,
> But know their rights, and, knowing, dare maintain,
> Prevent the long-aimed blow,
> And crush the tyrant while they rend the chain,—
> These constitute a State."

A farmer cannot become a millionaire in his business; but great wealth in the hands of a few, we all know, is a standing menace to free institutions. Also out of the extreme poverty of the masses are bred evil forces, which, if not held in check by the strong arm of the law, will destroy *all* forms of government. These thoughts are best expressed in the oft-quoted words of Goldsmith: —

> "Ill fares the land, to hastening ills a prey,
> Where wealth accumulates, and men decay."

We hear sometimes about the poverty of the New England farmer, but where is it located? What community of farmers has appealed to the authorities to start public works that they may have employment? How many rural neighborhoods are calling for the establishment of soup houses where their starving poor may be fed? We have had two years of hard times, causing in cities much destitution and misery; but, beyond a shrinking in the value of their property and a need of a little closer economy, the farmers have not greatly suffered. In view of all this, with the experience of the past two years before them, it seems to me that farmers ought to be thankful for the favorable conditions which surround them, and to take courage.

It is true that we have a system of bounties and government aid to agriculture; but this is not offered as alms to individual farmers, but for the purpose of forwarding an industry which in turn will be a guarantee of the government's stability. This thought lies, or should lie, back of all government aid. Washington had it in mind when in 1794 he wrote: "I know of no pursuit in which more real and important service can be rendered to any country than by improving its agriculture." In his last message to Congress he says: "It will not be doubted that, with reference either to individual or national welfare, agriculture is of primary importance. In proportion as nations advance in population and other circumstances of maturity, this truth becomes more apparent, and renders the cultivation of the soil more and more an object of public patronage." The State and national governments have recognized this truth, and have generously endowed agricultural colleges and established experiment stations. I count it as a good omen that farmers are more and more studying the science of farming, and are seeking the information which these scientific schools can give.

Again, it can be said of farming as an occupation that it develops and stimulates individual freedom and independence. In the atmosphere of the farm the tyranny of capital on the one hand and the tyranny of the trades unions on the other cannot flourish. The farmer, combining in himself both labor and capital, can say to these warring forces, "A plague on both your houses." Let the walking delegate come to him and tell him how many hours he may work, and whom to hire, and he will find himself consigned to a warmer climate than that of our New England.

I should miss the best feature of farm life if I omitted the opportunity it gives of establishing and maintaining an ideal home. "In the homes of its people is the security of a nation." Here can the evils which would destroy society be best met and overcome, and our New England farmers come short of their high privilege, if their homes are not fortresses against which all the turbulent elements in society beat in vain.

> "None love their country, but who love their home;
> For freedom can with those alone abide
> Who wear the golden chain with honest pride,
> Of love and duty at their own fireside."

I have alluded to the sturdy character developed on the New England farms in the eighteenth century. It is not the fault of the farm if it is not still the nursery of those characteristics which have made New England's history, and which were never more needed than now. The study of the past and present conditions of farming which the preparation of this paper made necessary, has strengthened my faith in the future prosperity of the New England farmer. The West is no longer making such large drafts of youth from us, and her competition will be less severe as her home markets make larger demands upon the Western farmers. Also that other factor, manufacturing, which has helped to deplete the rural ranks, has spent much of its force. The West and shop will still recruit some from the New England farm, but not in such a tidal wave as we have seen in the past.

The chief factor in the future progress of farming is the farmer himself. Agricultural colleges and experiment stations, wise legislation and organized agriculture by its State boards and various other societies may assist; but the individual farmer, in his lot and place, must work out his own destiny. To do this successfully brain and brawn must go together. The *study* of his farm and its needs will add strength and vigor to his mind, as the *work* of the farm does to his body. One of the best signs of the times is the increased respect which farmers are having for their vocation. As respect and faith come in, discontent with all of the evils in its train will go out. The farmer will feel that he is in partnership with nature, and, we hope, will recognize his wife and children as active members of the firm. The ideal farmer will be neither a drone nor a drudge, and his family will have time for the improvement of both mind and body. As his pride in his work increases, it will be shown in a more thorough cultivation of the farm, not forgetting the removal from the farm, at perhaps the good wife's suggestion, of all the unsightly objects that mar its attractiveness. Once let this spirit of improvement get possession, and the farm cannot hold it all; it will run over farm bounds into the highways and hedges, or rather the hedges in the highways, and country roads, and cemeteries and all public places will feel its force. Filled with this spirit, the farmer will become a better citizen, and, instead of kicking against all improvement, — if it costs anything, — he will be up with the times in all that is good; he will be more public-spirited than he is now, and without great wealth, yet with enough for all his needs, he can contentedly echo these sentiments of Whittier: —

"Give fools their gold, and knaves their power,
Let fortune's bubbles rise or fall,
Who sows a field, or trains a flower,
Or plants a tree, is more than all.
For he who blesses most is blest,
And God and man shall own his worth
Who toils to leave, as his bequest,
An added beauty to the earth."

DIRECTORY

OF THE

Agricultural and Similar Organizations in the State.

FEBRUARY, 1895.

STATE BOARD OF AGRICULTURE, 1895.

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His Excellency FREDERIC T. GREENHALGE.
His Honor ROGER WOLCOTT.
Hon. WM. M. OLIN, *Secretary of the Commonwealth.*
H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*
C. A. GOESSMANN, Ph.D., LL.D., *Chemist of the Board.*
WM. R. SESSIONS, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term Expires.
JAMES S. GRINNELL of Greenfield,	1896
SPRAGUE S. STETSON of Lakeville,	1897
DWIGHT A. HORTON of Northampton,	1898

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agr'l and Hort'l),	F. W. SARGENT of Amesbury,	1897
Attleborough (Agr'l Assoc'n),	ISAAC ALGER of Attleborough,	1897
Barnstable County,	JOHN BURSLEY of West Barnstable,	1898
Berkshire,	SAMUEL M. RAYMOND of Hinsdale,	1897
Blackstone Valley,	HENRY A. COOK of Northbridge (P. O. Whitinsville),	1897
Bristol County,	N. W. SHAW of North Raynham,	1896
Deerfield Valley,	CHAS. E. WARD of Buckland,	1896
Eastern Hampden,	W. M. TUCKER of Monson,	1897
Essex,	F. H. APPLETON of Peabody (P. O. Lynnfield),	1896
Franklin County,	GEO. E. TAYLOR of Shelburne,	1898
Hampden,	F. E. CLARK of Wilbraham,	1897
Hampshire,	WM. P. BROOKS of Amherst,	1898
Hampshire, Franklin and Hampden,	C. B. LYMAN of Southampton,	1897
Highland,	H. A. BARTON, Jr., of Dalton,	1896
Hillside,	WM. BANCROFT of Chesterfield,	1896
Hingham (Agr'l and Hort'l),	EDMUND HERSEY of Hingham,	1897
Hoosac Valley,	WM. H. GOVE of North Adams (P. O. Blackinton),	1897
Housatonic,	F. A. PALMER of Stockbridge,	1897
Marshfield (Agr'l and Hort'l),	JOHN H. BOURNE of Marshfield,	1897
Martha's Vineyard,	H. G. NORTON of West Tisbury,	1898
Massachusetts Horticultural,	E. W. WOOD of West Newton,	1897
Massachusetts Society for Promoting Agriculture,	FRANCIS SHAW of Wayland,	1897
Middlesex North,	A. C. VARNUM of Lowell,	1898
Middlesex South,	ISAAC DAMON of Wayland (P. O. Cochituate),	1896
Nantucket,	J. S. APPLETON, Jr., of Nantucket,	1897
Oxford,	W. M. WELLINGTON of Oxford,	1898
Plymouth County,	AUGUSTUS PRATT of No. Middleborough,	1896
Spencer (Far's and Mech's Assoc'n),	JOHN G. AVERY of Spencer,	1898
Union (Agr'l and Hort'l),	CURTIS M. BLAIR of Blandford,	1898
Weymouth (Agr'l and Ind'l),	QUINCY L. REED of South Weymouth,	1897
Worcester,	C. L. HARTSHORN of Worcester,	1896
Worcester East,	W. A. KILBOURN of South Lancaster,	1897
Worcester North,	GEORGE CRUICKSHANKS of Fitchburg,	1896
Worcester North-west (Agr'l and Mech'l),	A. D. RAYMOND of Royalston,	1898
Worcester South,	G. L. CLEMENCE of Southbridge (P. O. Globe Village),	1898
Worcester County West,	E. A. HARWOOD of North Brookfield,	1896

ORGANIZATION OF THE BOARD.

OFFICERS.

President, . . .	His Excellency FREDERIC T. GREENHALGE, *Ex Officio.*
1st Vice-President, .	JAMES S. GRINNELL of Greenfield.
2d Vice-President, .	FRANCIS H. APPLETON of Peabody (Post-office, Lynnfield).
Secretary, . . .	WM. R. SESSIONS of Hampden. Office, Commonwealth Building, Boston.

Members Board of Control State Agricultural Experiment Station.

Messrs. C. L. Hartshorn of Worcester and Geo. L. Clemence of Globe Village.

COMMITTEES.

Executive Committee.

Messrs. E. W. Wood of West Newton.
W. A. Kilbourn of South Lancaster.
Wm. Bancroft of Chesterfield.
C. L. Hartshorn of Worcester.
A. C. Varnum of Lowell.
Wm. P. Brooks of Amherst.
Francis H. Appleton of Peabody.

Committee on Agricultural Societies.

Messrs. W. A. Kilbourn of South Lancaster.
Q. L. Reed of South Weymouth.
N. W. Shaw of North Raynham.
F. E. Clark of Wilbraham.
W. H. Gove of Blackinton.

Committee on Domestic Animals and Sanitation.

Messrs. Wm. Bancroft of Chesterfield.
Isaac Damon of Wayland.
W. M. Tucker of Monson.
Geo. E. Taylor of Shelburne.
Francis Shaw of Wayland.

Committee on Gypsy Moth, Insects and Birds.

Messrs. E. W. Wood of West Newton.
A. Pratt of North Middleborough.
F. W. Sargent of Amesbury.
S. S. Stetson of Lakeville.
John G. Avery of Spencer.

Committee on Dairy Bureau and Agricultural Products.

Messrs. C. L. Hartshorn of Worcester.
D. A. Horton of Northampton.
Geo. L. Clemence of Globe Village.
F. A. Palmer of Stockbridge.
C. B. Lyman of Southampton.

Committee on Agricultural College and Education.

Messrs. A. C. Varnum of Lowell.
Geo. Cruickshanks of Fitchburg.
E. A. Harwood of North Brookfield.
John Bursley of West Barnstable.
A. D. Raymond of Royalston.

Committee on Experiments and Station Work.

Messrs. Wm. P. Brooks of Amherst.
C. L. Hartshorn of Worcester.
C. E. Ward of Buckland.
H. A. Cook of Whitinsville.
Geo. L. Clemence of Globe Village.

Committee on Forestry, Roads and Roadside Improvements.

Messrs. Francis H. Appleton of Peabody.
J. H. Bourne of Marshfield.
Isaac Alger of Attleborough.
S. M. Raymond of Hinsdale.
J. S. Appleton, Jr , of Nantucket.

The Secretary is a member, *ex officio*, of each of the above committees.

DAIRY BUREAU.

Messrs. C. L. Hartshorn of Worcester, Geo. L. Clemence of Globe Village, D. A. Horton of Northampton, *appointed by the Governor.* Secretary Wm. R. Sessions, *Executive Officer.* Geo. M. Whitaker of Boston, *Assistant Executive Officer, appointed by the Governor.*

SPECIALISTS.

By Election of the Board.

Chemist, ...	Dr C. A. Goessmann, ...	Amherst.
Entomologist, . . .	Prof. C. H. Fernald, ...	Amherst.
Botanist and Pomologist, .	Prof. S. T Maynard, ...	Amherst.
Veterinarian, . . .	Prof James B. Paige, ...	Amherst.
Engineer, ...	Wm. Wheeler, ...	Concord.
Ornithologist, . . .	E. H. Forbush, ...	Malden.

By Appointment of the Secretary.

Librarian and Curator, F. H. Fowler, B.Sc., *First Clerk.*

MASSACHUSETTS AGRICULTURAL COLLEGE.

Location, Amherst, Hampshire County.

Board of Trustees.

	Term Expires.
Samuel C. Damon of Lancaster,	1896
James Draper of Worcester,	1896
Henry S. Hyde of Springfield,	1897
Merritt I. Wheeler of Great Barrington,	1897
James S. Grinnell of Greenfield,	1898
Joseph A. Harwood of Littleton,	1898
William H. Bowker of Boston,	1899
J. D. W. French of North Andover,	1899
J Howe Demond of Northampton,	1900
Elmer D. Howe of Marlborough,	1900
Francis H. Appleton of Peabody,	1901
William Wheeler of Concord,	1901
Elijah W. Wood of West Newton,	1902
Chas. A. Gleason of New Braintree,	1902

Members ex Officio.

His Excellency Governor F. T. Greenhalge,
President of the Corporation.

Henry H. Goodell, M.A., LL.D.,	*President of the College.*
Frank A. Hill,	*Secretary of the Board of Education.*
William R. Sessions,	*Secretary of the Board of Agriculture.*

Officers Elected by the Board of Trustees.

James S. Grinnell of Greenfield,	*Vice-President of the Corporation.*
William R. Sessions of Hampden,	*Secretary.*
Prof. Geo. F. Mills of Amherst,	*Acting Treasurer.*
Charles A. Gleason of New Braintree,	*Auditor.*

Board of Overseers.

The State Board of Agriculture.

Examining Committee of the Board of Agriculture.

Messrs. Varnum, Cruickshanks, Harwood, Bursley and A. D. Raymond.

Hatch Experiment Station of the Massachusetts Agricultural College.

Henry H. Goodell, M.A., LL.D.,	*Director.*
William P. Brooks, B.Sc.,	*Agriculturist.*
Samuel T. Maynard, B Sc,	*Horticulturist.*
Charles H. Fernald, Ph.D.,	*Entomologist.*
Clarence D. Warner, B.Sc.,	*Meteorologist.*

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION.

Location, Amherst, Hampshire County.

Board of Control.

His Excellency F. T. Greenhalge, Governor of the Commonwealth, *President ex officio.*

	Term Expires.
Calvin L. Hartshorn of Worcester,	1897
Geo. L. Clemence of Southbridge,	1898
Elected by the State Board of Agriculture.	
Elmer D. Howe of Marlborough,	1897
J. Howe Demond of Northampton,	1896
Elected by the Board of Trustees of the Massachusetts Agricultural College.	
Francis H. Appleton of Peabody,	1898
Elected by the Massachusetts Society for Promoting Agriculture.	
Wm. H. Porter of Agawam,	1895
Elected by the Massachusetts State Grange.	
William C. Strong of Newton (P. O. Waban),	1898
Elected by the Massachusetts Horticultural Society.	

Henry H. Goodell, M.A., LL.D., of Amherst, *President of the Massachusetts Agricultural College.*

Charles A. Goessmann, Ph.D., LL.D., of Amherst, *Director of the Station.*

William R. Sessions of Hampden, *Secretary of the State Board of Agriculture.*

Officers Elected by the Board of Control.

Henry H. Goodell, M.A., LL D., of Amherst,	*Vice-President.*
William R. Sessions of Hampden,	*Secretary and Auditor.*
Charles A. Goessmann, Ph.D., LL.D., of Amherst,	*Director, Chemist and Acting Treasurer.*

BOARD OF CATTLE COMMISSIONERS.

	Term Expires.
Fred'k S. Osgood, D.V.S., of Boston, *Chairman*,	1897
Chas. P. Lyman, F.R.C.V.S., of Boston, *Secretary*,	1896
Maurice O'Connell, D.V.S., of Holyoke,	1895
L. F. Herrick of Millbury,	1897
Charles A. Dennen of Pepperell,	1897

AGRICULTURAL SOCIETIES INCORPORATED BY SPECIAL ACT OF LEGISLATURE, AND REPRESENTED ON THE BOARD OF AGRICULTURE.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Amesbury and Salisbury,* .	C. W. Woods, Newbury.	A. H. Fielden, Amesbury.	W. H. Dewhurst, Amesbury.
Attleborough (Agric'l Asso.),	John Thacher, Attleborough.	Geo. Randall, Attleborough.	S. M. Holman, Attleborough.
Barnstable County, . .	John Simpkins, Yarmouth.	H. M. Hutchings, Barnstable.	Albert F. Edson, Barnstable.
Berkshire, ...	Wesley B. Barton, Dalton.	Frank H. Cande, Pittsfield.	J W. Lewis, Pittsfield.
Blackstone Valley, . .	Jas. M. Farnum, Uxbridge.	Augustus Story, Uxbridge.	F. W. Barnes, Uxbridge.
Bristol County, . . .	W. C. Baylies, Taunton.	A. B. Hodges, Taunton.	E. C. Holt, Taunton.
Deerfield Valley, . . .	D. W. Temple, Shelburne Falls.	S. W. Hawkes, Charlemont.	E. F. Haskins, Charlemont.
Eastern Hampden, . .	Chas. E. Fuller, Palmer.	O. P. Allen, Palmer.	O. P. Allen, Palmer.
Essex, ...	Francis H. Appleton, Lynnfield.	J. M. Danforth, Lynnfield Centre.	G. L. Streeter, Salem.
Franklin County, . . .	J. D. Avery, Buckland.	Wm. S. Allen, Greenfield.	Wm. S. Allen, Greenfield.
Hampden, ...	Chas. F. Fowler, Westfield.	Wm. H. Porter, Agawam.	E. S. Batchelder, Springfield.
Hampshire, ...	**Wm. P. Brooks, Amherst.**	J. W. Kellogg, Amherst.	J. W. Kellogg, Amherst.
Hampshire, Franklin and Hampden, ...	E. E. Wood, Northampton.	S. S. Warner, Northampton.	D. J. Wright, Northampton.
Highland, ...	Spencer A. Knox, Chester.	John T. Bryan, Middlefield.	M. J. Smith, Middlefield.
Hillside, ...	S. W. Clark, Plainfield.	William G. Atkins, West Cummington.	R. R. Packard, Cummington.
Hingham,*	E. L. Ripley, Hingham.	William H. Thomas, Hingham	Reuben Sprague, Hingham.
Hoosac Valley, . . .	Geo. P. Carpenter, Blackinton.	George F. Miller, North Adams.	M. R. Ford, North Adams.
Housatonic, ...	H. L. Rowe, Egremont.	Frank H. Briggs, Great Barrington.	W. B. Sanford, Great Barrington.
Marshfield,*	Geo. M. Baker, Marshfield.	Francis Collamore, North Pembroke.	Francis Collamore, North Pembroke.
Martha's Vineyard, . .	U. E. Mayhew, West Tisbury.	B. T. Hillman, Edgartown.	Geo H. Luce, West Tisbury.
Massachusetts Horticultural,	N. T. Kidder, Milton.	Robert Manning, Boston.	C. E. Richardson, Cambridgeport.
Massachusetts Society for Promoting Agriculture, .	- - -	Francis H. Appleton, Lynnfield.	J. C. Rogers, Boston.
Middlesex North, . . .	A. C. Varnum, Lowell.	Geo. B. Coburn, Lowell.	S. Drewett, Lowell
Middlesex South, . . .	Isaac Damon, Cochituate.	Edgar Potter, South Framingham.	H. L. Davenport, Framingham.
Nantucket, ...	J. S. Appleton, Jr , Nantucket.	J. F. Murphey, Nantucket.	Asa C. Jones, Nantucket.
Oxford, ...	A. R. Snow, Webster.	W. H. H. Thurston, Oxford.	W. H. H Thurston, Oxford.
Plymouth County, . .	A. Pratt, North Middleborough.	George M. Hooper, Bridgewater.	Paul O. Clark, Bridgewater.

* And horticultural.

AGRICULTURAL SOCIETIES, ETC. — *Concluded.*

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Spencer (Farmers' and Mechanics' Association), .	I. L. Prouty, Spencer.	F. B. Watson, Spencer.	A. W. Curtis, Spencer.
Union,*	Amasa Stewart, Blandford.	E. W. Boise, Blandford.	A. H. Nye, Blandford.
Weymouth (Ag'l and Ind.), .	Minot Tirrell, South Weymouth.	H. Wilbur Dyer, South Weymouth.	C. S. Stowell, South Weymouth.
Worcester, ...	L. F. Herrick, Millbury.	John B. Bowker, Worcester.	John B. Bowker, Worcester.
Worcester East, . . .	John E. Thayer, Lancaster.	W. A. Kilbourn, South Lancaster.	Lucius Field, Clinton.
Worcester North, . . .	– – –	John W. Ogden, Fitchburg.	N. C. Upham, Fitchburg.
Worcester North-west (Ag'l and Mechanical), . .	W. H. Lee, New Haven, Conn.	J. H. Humphrey, Athol Center.	T. H. Goodspeed, Athol Center.
Worcester South, . . .	Thos. H. Jones, Warren.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West, .	Horatio Moore, New Braintree.	Matthew Walker, Barre.	Charles H. Follansby, Barre.

* And horticultural.

HORTICULTURAL SOCIETIES.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Haverhill, ...	Haverhill, ...	Jared M. Davis, Haverhill.	James Howe, Haverhill.
Hampden County, ...	Springfield, ...	J. E. Taylor, Springfield.	B. L. Bragg, Springfield.
Houghton, ...	Lynn, ...	Walter B. Allen, Lynn.	Edith C. Noyes, Lynn.
Hyde Park, ...	Hyde Park, ...	H. J. Stockford, Hyde Park.	J. R. Andrews, Hyde Park.
Massachusetts, ...	Boston, ...	N. T. Kidder, Milton.	Robert Manning, Boston.
Newton, ...	Newton, ...	D. D. Slade, Chestnut Hill.	L. H. Farlow, Newton.
Springfield Amateur, ...	Springfield, ...	Joseph Aumer, Springfield.	George H. Lapham, Springfield.
Wakefield, ...	Wakefield, ...	W. S. Ripley, Wakefield.	Mrs. J. F. Woodward, Wakefield.
Worcester County, ...	Worcester, ...	H. L. Parker, Worcester.	E. W. Lincoln, Worcester.

FARMERS' AND MECHANICS' ASSOCIATIONS.

Bolton,	Bolton,	H. F. Haynes, Bolton.	Geo. H. Brigham, Bolton.
Leominster,	Leominster,	A. L. Whitney, Leominster.	C. H. Rice, Leominster.
Middlesex and Worcester,	Hudson,	Rufus H. Hapgood, Hudson.	Josiah S. Welsh, Hudson.
Needham,	Needham,	Chas. F. Smith, Wellesley.	A. K. Tisdale, Dover.
Oakham,	Oakham,	H. P Austin, Oakham.	W. W. Russell, Oakham.
Princeton,	Princeton,	J. C. F. Mirick, Princeton.	J. E. Merriam, Princeton.
Westminster,	Westminster,	W. H. Waterhouse, Westminster.	J. A. Baker, So. Westminster.

FARMERS' AND MECHANICS' CLUBS.

Ashburnham,	Ashburnham,	Chas. W. Whitney, Ashburnham.	Chas. H. White, Ashburnham.
Ashby,	Ashby,	E. A. Hubbard, Ashby.	C. S. Blake, Ashby.
Belchertown,	Belchertown,	G. L Kent, Belchertown.	J. J. Overing, Belchertown.
Berlin,	Berlin,	P. B. Southwick, Berlin Centre.	J. D. Southwick, Berlin Centre.
Groton,	Groton,	- - -	Charles Woolley, Groton.
Holden,	Holden,	Franklin Moore, Holden.	L. A. Peters, Worcester.
Pepperell,	Pepperell,	A. S. Shattuck, Pepperell.	S. R. Merrill, Pepperell.
Shirley,	Shirley,	E. G. Adams, Shirley.	- - -
Shrewsbury,	Shrewsbury,	E. A. Bartlett, Shrewsbury.	F. J. Stone, Shrewsbury.
West Acton,	West Acton,	Isaac Reed, West Acton	C. B. Stone, West Acton.
Wilmington,	Wilmington,	H. Allen Sheldon, Wilmington.	E. M. Nichols, Wilmington.

FARMERS' CLUBS.

Ashfield,	Ashfield,	John M Sears, Ashfield.	A. G. Howes, Ashfield.
Boxborough,	Boxborough,	N. E. Whitcomb, West Acton.	J. F. Hayward, West Littleton.
Buckland,	Buckland,	F. L. Warfield, Buckland.	E. F. Smith, Buckland.
Chamberlain District,	Worcester,	B. W. Potter, Worcester.	S. A. Burgess, Worcester.
East Charlemont,	East Charlemont,	Reuben Streeter, East Charlemont.	J. G. Johnson, East Charlemont.
Easthampton,	Easthampton,	L. E. Parsons, Easthampton.	Geo. H. Parsons, Easthampton.
Franklin,	Franklin,	John L Fisher, City Mills.	L W. Daniels, Franklin.
Halifax,	Halifax,	Otis Pratt, Halifax.	Mrs. J. S. Pope, Halifax.

FARMERS' CLUBS — *Concluded.*

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Huntington,	Huntington,	C. H. Strong, Norwich.	H. W. Stickney, Norwich.
Lancaster,	Lancaster,	George W. Morse, South Lancaster.	F. A. Hanaford, South Lancaster.
Lunenburg,	Lunenburg,	C E. Cox, Lunenburg.	James Hildreth, 2d, Lunenburg.
New Braintree,	New Braintree,	D. C. Wetherell, New Braintree.	Horatio Moore, New Braintree.
New Salem,	New Salem,	D. F. Carpenter, Millington.	Willard Putnam, Cooleyville.
North Westport,	North Westport,	E. L. Gifford, North Westport.	A. S. Sherman, North Westport.
Practical,	Egremont,	H. Z. Cande, Sheffield.	Mrs. C. B. Benedict, South Egremont.
Rehoboth,	Rehoboth,	F. A. Bliss, Pawtucket, R. I.	A. A. Bliss, Pawtucket, R. I.
Rowley,	Rowley,	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
Royalston,	Royalston,	A. D. Raymond, Royalston.	G. E. Pierce, Royalston.
Rutland,	Rutland,	Ira G. Dudley, West Rutland.	Mrs. J. W. Munroe, Rutland.
Southborough,	Southborough,	Wm. H. Buck, Southborough.	D. W. C. McMasters, Southborough.
South Bristol,	New Bedford,	Franklyn Howland, Acushnet.	A. P. R. Gilmore, Long Plain.
Sterling,	Sterling,	Geo. M. Stuart, Sterling.	Ezra Sawyer, Sterling.
Tatnuck,	Worcester,	Elliot Moore, Worcester.	W. W. Clapp, Worcester.
Upton,	Upton,	Chas. A. Whitney, Upton.	P. W. Rockwood, Upton.
Waltham,	Waltham,	M. R. Leonard, Waltham.	A. Starbuck, Waltham.
West Bridgewater,	West Bridgewater,	F. E. Howard, West Bridgewater.	Mrs. H. J. LeLacheur, W. Bridgewater.
West Brookfield,	West Brookfield,	W. E. Patrick, Warren.	L. H. Chamberlain, West Brookfield.
West Newbury,	West Newbury,	E. G. Nason, West Newbury.	A. L. Moore, Newburyport.
West Peabody,	West Peabody,	Mrs. F. C. Durkee, West Peabody.	Bertha G. Small, West Peabody.
Wilbraham,	Wilbraham,	B. F. Green, North Wilbraham.	H. M. Bliss, Wilbraham.

MISCELLANEOUS.

Agricultural Library Association,	Swansea,	Jas. E. Easterbrooks, Swansea Centre.	A. E. Arnold, Swansea Centre.
Boston Market Gardeners' Association,	Boston and Vicinity,	W. W. Rawson, Arlington.	C. A. Learned, Arlington.
Bristol Co. Fruit Growers' Association,	Dighton.	Chas. N. Simmons, Dighton.	Wm. P. Eddy, Dighton.

* Bay State Agricultural Society, . .	Boston, ...	J. D. W. French, Boston.	C. M. Weld, Brookline.
* Brockton Agricultural Society, . .	Brockton, ...	H. W. Robinson, Boston.	Ira Copeland, Brockton.
Burlington Agricultural Society, . .	Burlington, . . .	Augustus Prouty, Burlington.	H. H. Nichols, Burlington.
Cranberry Growers' Association, . .	Cape Cod District, . .	J. J. Russell, Plymouth.	I. T. Jones, Sandwich.
Farmers' and Gardeners' Club, . . .	Hanson, ...	George F. Simpson, Hanson.	F. S. Thomas, M.D., Hanson.
Franklin Harvest Club, ...	Connecticut Valley, . .	C. F. Fowler, Westfield.	C. B. Lyman, Southampton.
Hampden Harvest Club, ...	Connecticut Valley, . .	The members alternately.	J. N. Bagg, West Springfield.
* Westborough Agricultural Society, .	Westborough, . . .	Wm. N. Barrett, Westborough.	F. P. Rogers, Westborough.
Young Men's Harvest Club, . . .	Ludlow, ...	H. E. Miller, Ludlow.	E. N. Fisher, Ludlow.
Young People's Agricultural Club, . .	Wilbraham, . . .	John Isham, Hampden.	Albert M. Soule, Wilbraham.

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* Incorporated under general laws.

MASSACHUSETTS PATRONS OF HUSBANDRY.

Officers of the State Grange, 1895.

Master,	E. D. Howe of Marlborough.
Overseer,	A. C. Stoddard of North Brookfield.
Lecturer,	J. W. Stockwell of Sutton.
Steward,	E. A. Emerson of Haverhill.
Assistant Steward,	Wm. N. Howard of South Easton.
Chaplain,	Rev. C. S. Walker of Amherst.
Treasurer,	F. A. Harrington of Worcester.
Secretary,	W. C. Jewett of Worcester.
Gate Keeper,	C. H. Deming of Lanesborough.
Pomona,	Mrs. Elbridge Cushman of Lakeville.
Flora,	Mrs. Lizzie Huntington Sargent of Amesbury.
Ceres,	Mrs. Emma Eaton of Fitchburg.
Lady Assistant Steward,	Mrs. Jennie F. Williams of East Douglas.

Executive Committee.

H. A. Barton, Jr.,	Dalton.
C. A. Dennen,	Pepperell.
Geo. L. Clemence,	Southbridge.

Deputies.

J. B. Parkin,	Holliston.
Geo. B. Bradley,	Methuen.
Geo. A. Hastings,	Boylston Centre.
James Hildreth,	Lunenburg.
W. B. Barton,	Dalton.
Geo. L. Ladd,	Sturbridge.
Jas. F. Whitcomb,	Athol.
Marcellus Boynton,	Central Village.
Wm. N. Howard,	South Easton.
F. H. Stevens,	Stow.
W. H. Porter,	Agawam.
H. A. Wheeler,	Berlin.
Mrs. Susan M. Chase,	Medfield.
Mrs. Mary Q. Kinsman,	Ipswich.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Pomona Granges.			
Middlesex and Norfolk, No. 1,	H. N. Rogers, Holliston.	Abel F. Stevens, Wellesley.	Mrs. N. H. Fales, Pondville.
Essex County, No. 2,	Peter Holt, Jr., North Andover.	E. A. Emerson, Haverhill.	Matilda B. Lund, West Boxford.
Middlesex and Worcester, No. 3,	John Wooldredge, Lunenburg.	Mrs. Ella Mayo, Ashby.	Mrs. Annie E. Robbins, Lowell.
Franklin and Worcester, No. 4,	L. H. Woodbury, Royalston.	D. L Crandall, Orange.	Mrs. Flora J. Butterworth, Athol.
Worcester West, No. 5,	C. N. Winship, Barre.	Lyman Randal, Petersham.	Thomas B. Clark, Baldwinville.
Berkshire County, No 6,	Chas. Shaylor, Lee.	F. F. Watkins, Hinsdale.	M. Agnes Young, Dalton.
Worcester Central, No. 7,	Henry W Carter, Millbury.	Mrs. Jennie F. Williams, East Douglas.	Lyman M. Rice, Grafton.
Hampshire County, No. 8,	Herbert Sabin, Amherst.	Howard C. West, Belchertown.	Miss Sarah E. Mason, Northampton.
Worcester Southwest, No. 9,	Henry W. Nichols, Sturbridge.	L. Emerson Barnes, North Brookfield.	Miss Mary E. Fairbanks, W. Brookfield.
Worcester and Norfolk, No. 10,	Carroll E. White, Bellingham.	Abbie M. Lapham, Mendon.	A. W. Gaskill, Mendon.
Borough, No. 11,	F. H. Stevens, West Acton.	Mrs. Addison Keyes, Berlin.	Mrs. Mary S. Wood, Northborough.
Springfield, No. 12,	F. G. Bennett, Ludlow.	W. S. Clark, Granby.	Mrs. C. Leonard Hayward, Agawam.
Old Colony, No. 13,	Samuel D. Chase, Brookville.	Marcellus Boynton, Central Village.	Mrs. Geo. W. Stevens, South Braintree.
District Granges.			
Lancaster,	George A. Hastings, Boylston.	W. A. Kilbourn, S. Lancaster.	Ida A. Cunningham, Lancaster.
Subordinate Granges.			
Northfield, No. 3,	L. R. Smith, East Northfield.	T. R. Callendar, Northfield.	Mabel Lyman, East Northfield.
Groton, No 7,	Francis M. Boutwell, Groton.	– – –	Eva A. Clark, Groton.
Barre, No. 9,	Mrs. Rebecca P. Smith, Barre.	Mrs. Mary Osgood, Barre.	E. W. Nourse, Barre.
Amherst, No. 16,	C. L. Nims, Amherst.	H. M. Thompson, Amherst.	Alice F. Dickinson, Amherst.
Hinsdale, No. 19,	C. C. Robinson, Jr., Hinsdale.	Mrs. F. F. Watkins, Hinsdale.	John S. Cole, Hinsdale.
Lanesborough, No. 21,	S. L. Miner, Lanesborough.	W. S. Boyce, Lanesborough	Chas. H. Deming, Lanesborough.
Worcester, No. 22,	J. E. Goodell, West Boylston.	Mary W. Kilborn, Worcester.	Ellen M. Flagg, Worcester.
Dalton, No. 23,	W. B. Warren, Dalton.	E. L. Brown, Dalton.	M. Agnes Young, Dalton.
Sterling, No 53,	Geo. A. Fitch, Clinton.	A. H. Melendy, Sterling.	Joseph R. Graham, Clinton.
Auburn, No. 60,	J. H. Prouty, Auburn.	Mrs. W. H. Stockwell, West Millbury.	Grace L Marcy, Auburn.
"Union" of Belchertown, No. 64,	Eugene Randall, Belchertown.	F. L. Stebbins, Belchertown.	M. G. Ward, Belchertown.
Hardwick, No. 67,	George Manly, Hardwick.	Mrs. W. A. Newcomb, Hardwick.	W. A. Newcomb, Hardwick.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Phillipston, No 70,	G. R. Johnson, Templeton.	C. A. Moore, Baldwinville.	M. B. Hager, Templeton.
"Prescott" of Pepperell, No. 73,	A. N. Blood, Pepperell.	John L. Boynton, Pepperell.	Edmund S. Blood, Pepperell.
Paxton, No. 76,	Ledyard Bill, Paxton.	Oliver Goodnow, Paxton.	Mrs. S. E. Glidden, Paxton.
Holden, No. 78,	Mrs. G. S. Graham, Holden.	Mrs. R. D. Rice, Holden.	Mrs. S. N. Hubbard, Holden.
Spencer, No. 79,	Edson C. Bemis, Spencer.	Edward Warren, Spencer.	John W. Bigelow, Spencer.
"Manhan" of Southampton, No. 82,	J. S. Frary, Southampton.	Mrs. C. P. Gridley, Southampton.	Mrs. Geo. K. Edwards, Southampton.
North Orange, No. 86,	M. L. Gerhard, Tully.	Mrs. Una B. Fish, Tully.	Mrs. Ellen S. Prentice, Tully.
Lee, No. 88,	Chas. G. Hinckley, Lee.	Chas. H. Shaylor, Lee.	Chas. O. Swift, Lee.
Charlton, No. 92,	H. M. Dodge, Charlton.	A. M. Dodge, Charlton.	Horatio L. Clark, Southbridge.
Grafton, No. 93,	Henry R. Leland, Grafton.	Mrs. Silas E. Stowe, Grafton.	Lyman M. Rice, North Grafton.
Petersham, No. 95,	Henry H. Lindsey, Petersham.	Mrs. R. J. Stone, Petersham.	Mrs. Mary E. Prouty, Petersham.
Shrewsbury, No. 101,	Wm. E. Rice, Shrewsbury.	Emily R. Carey, Shrewsbury.	Anne S. Rice, Shrewsbury.
Stow, No. 103,	Charles W. Crandall, Stow.	Mrs. George Bolam, Stow.	Mrs. U. M. Lewis, Stow.
"Garfield" of North Dana, No. 104,	J. E. Doubleday, North Dana.	Mrs. Eliza Chelifoux, North Dana.	Mary Doubleday, North Dana.
Marlborough, No. 105,	Joseph Walker, Marlborough.	L. O. Richardson, Marlborough.	Mrs. Abbie A. Nichols, Marlborough.
West Boylston, No. 106,	Franklin Walker, West Boylston.	Miss Helen I. Pierce, West Boylston.	Amelia D. Lord, West Boylston.
Millbury, No. 107,	C. H. Stockwell, West Millbury.	I. E. Howe, Millbury.	Mrs. J. C. Hayward, Millbury.
Hudson, No. 108,	W. R. Coolidge, Hudson.	L. W. Bruce, Hudson.	Mary E. Hall, Hudson.
Sutton, No. 109,	P. Dwight King, Sutton.	Dr. E. M. Welch, Sutton.	Miss Sarah M. Mills, Sutton.
Sherborn, No. 110,	G. L. Whitney, South Framingham.	Chas. O. Littlefield, Sherborn.	Miss A. L. Bickford, Sherborn.
Boylston, No. 111,	Geo. H. Longley, Boylston Centre.	Edward J. Walker, Clinton.	Lena A. Walker, Clinton.
"East Medway" of Millis, No. 112,	Henry E. Hosmer, Millis.	Everett D. Hooper, M.D., Millis.	Augustus L. Ware, Millis.
Framingham, No. 113,	J. M. Holbrook, Framingham.	Geo. E. Fay, Framingham.	Mary Furber, Framingham.
Medfield, No. 114,	Mrs. Susan M. Chase, Medfield.	George R. Chase, Medfield.	Mrs. W. W. Preston, Medfield.
Holliston, No 115,	Josiah B. Parkin, Holliston.	Mrs. H. N. Rogers, Holliston.	Miss Frances J. Hayes, Holliston.
Westborough, No. 116,	James Martin, Westborough.	Mrs. J. A. Gilmore, Westborough.	Mrs. C. L. Leonard, Westborough.
Dover, No. 117,	John A McGill, South Natick.	Thomas McGill, South Natick.	Fanny C. Paine, Dover.
Southborough, No 118,	Waldo A. Fay, Southborough.	Mrs. C. B. Sawin, Southborough.	Wilbur S. Richards, Cordaville.
Northborough, No. 119,	John K. Mills, Northborough.	Mrs. Mary S. Wood, Northborough.	Mrs. Amy G. Eldridge, Northborough.
Lancaster, No. 120,	E. T. Cunningham, Lancaster.	Mrs. E. T. Cunningham, Lancaster.	Miss E. C. Divoll, Lancaster.

Sudbury, No 121,	Lyman W. Gilbert, South Sudbury.	Francis F. Walker, South Sudbury.	Hattie J. Goodnow, Sudbury.
Templeton, No. 122,	Eugene C. Hersey, Templeton.	Lucien Gove, East Templeton.	Thomas B. Clark, Baldwinville.
Oxford, No. 123,	F. H. Clark, Oxford.	Mrs. D. M. Howe, Oxford.	Walter A. Lovett, Oxford.
Ashland, No. 124,	Henry C. Burnham, Ashland.	Mrs C. A. Cloyes, Ashland.	Fannie A. Pratt, Ashland.
Upton, No. 125,	T. A. Aldrich, West Upton.	Albert A. Chapman, West Upton.	L. Jenny Chapman, Upton.
Hubbardston. No. 126,	Fred M. Clark, Hubbardston.	Mrs. Annie Leach, Hubbardston.	J. Harry Allen, Hubbardston.
Amesbury, No. 127,	J. A. Davis, Amesbury.	Eben True, Amesbury.	Nellie A. Huntington, Amesbury.
North Andover, No. 128,	Edward A. Fuller, North Andover.	Geo. A. Rogers, North Andover Depot.	Lizzie F. Ingalls, North Andover.
Gardner, No. 130,	B. B. Goodale, Gardner.	Mrs. Minnie E. Barney, Gardner.	A. F. Johnson, Gardner.
Boxborough, No. 131,	N. E. Whitcomb, West Acton.	E. B. Cobleigh, W. Acton.	Mrs. Jennie A. Littlefield, West Acton.
North Brookfield, No. 132,	Carlton D. Richardson, North Brookfield.	L Emerson Barnes, North Brookfield.	Lizzie A. Doescher, North Brookfield.
West Dedham, No. 133,	W. W. Baker, West Dedham.	Addie L. Gay, West Dedham.	Annie L. Richardson, West Dedham.
Berlin, No. 134,	S. C. Chamberlain, Jr., Berlin.	Mrs. H A. Wheeler, Berlin.	Mrs. S C. Chamberlain, Berlin.
Norfolk, No. 135,	Albertus J. Whiting, Pondville.	Nathan H. Fales, Pondville.	Mrs. Sarah B. Sims, Norfolk.
Ipswich, No. 136,	F. A. Stackpole, Ipswich.	N. R. Underhill, Ipswich.	Chas. F Damon, Ipswich.
East Blackstone, No. 137,	Samuel V. Crane, Blackstone.	Mabel G. Scott, Blackstone.	Nancy A. Thayer, Blackstone.
Northampton, No. 138,	John McQuestion, Hadley.	Clayton S. Parsons, Northampton.	Miss Sarah E Mason, Northampton.
East Sandwich, No. 139,	John F. Carlton, East Sandwich.	R. F. Armstrong, East Sandwich.	Helen F. Holway, East Sandwich.
West Boxford, No. 140,	Henry M Killam, West Boxford.	Eliza R. Chadwick, West Boxford.	Matilda B. Lund, West Boxford.
Montague, No 141,	C M. Hemenway, North Leverett.	Mrs. J. R. Ball, Montague.	F A. Rist, Montague.
Bolton, No. 142,	Stanley E. Marsh, Bolton.	Mrs. C. S. Walcott, Bolton.	Mrs. Dorcas Babcock, Bolton.
Mendon, No. 143,	Moses U. Gaskill, Mendon.	Horace C. Adams, Mendon.	Albert W. Gaskill, Mendon.
Franklin, No. 144,	Henry R. Jenks, Franklin.	Lucius W. Daniels, Franklin.	Fred W. Handy, Franklin.
Douglas, No. 145,	Frank J. Mills, East Douglas.	Mary A. Richardson, Douglas.	Mabel Williams, East Douglas.
West Newbury, No. 146,	Robert L. Smith, West Newbury.	Mrs. L. M. Newell, West Newbury.	Mrs. H. L. Bailey, West Newbury.
West Springfield, No. 147,	H. L. Phelps, West Springfield.	E. C. Smith, West Springfield.	E. T. Sikes, West Springfield.
Swansea, No. 148,	Nathan Wood, Swansea Centre.	Thomas Weeks, Swansea Centre.	Susie C. Phillips, Swansea Centre.
Harvard, No. 149,	H. D. Stone, Still River.	J. H. Whitney, Harvard.	Isaac P. Baker, Harvard.
Concord, No. 150,	O. E. Patch, Concord.	Miss Mary H. Williams, Concord.	Geo. M. Parker, Bedford.
Agawam, No. 151,	Albert H. Brown, Agawam.	Mrs. S. J. Thompson, Agawam.	Mrs. C. Leonard Hayward, Agawam.
East Longmeadow, No. 152,	Elijah Cope, East Longmeadow.	Rev. W. H. Adams, East Longmeadow.	Mr. C. L. Cooley, East Longmeadow.
Wilbraham, No 153,	Frank A. Gurney, Wilbraham.	Clarence P. Bolles, Wilbraham.	Mrs. W. L. Phelps, Wilbraham.
Haverhill, No. 154,	Ira J. Webster, Haverhill.	G. F. S. Webster, Haverhill.	Isaiah J. Webster, Haverhill.
Methuen, No. 155,	John S. Crosby, Methuen.	Geo. M. Phippen, Lawrence.	Mary A. Crosby, Methuen.
West Bridgewater, No. 156,	H. Eugene Weston, Westdale.	M. K. Crosby, Matfield.	Chas. R. Packard, West Bridgewater.
Granby, No. 157,	A. J. Whitmarsh, Granby.	Mrs. A. J. Whitmarsh, Granby.	W. S. Clark, Granby.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Concluded.*

NAME.	MASTER.	LECTURER.	SECRETARY.
"Nemasket" of Middleborough, No. 158,	Sidney T. Nelson, Lakeville.	Annie D. Deane, Middleborough.	Chester E. Weston, Middleborough.
"Green River" of Williamstown, No. 159,	S. A. Hickox, South Williamstown.	Miss Jennie Stevens, Williamstown.	Mrs. Helen A. White, Williamstown.
South Hadley, No. 160,	H. E. Brainerd, South Hadley Falls.	Mrs. E. S. Johnson, Northampton.	Jennie A. Lyman, South Hadley.
"Laurel" of West Newbury, No. 161,	Robert J. Forsyth, West Newbury.	Mrs. Belle Bunker, Newburyport.	Albert W. Rogers, Newburyport.
Dartmouth, No. 162,	John O. Slocum, Dartmouth.	John W. Gifford, South Westport.	Jabez H. Slocum, Dartmouth.
Dudley, No. 163,	Monroe W Ide, Webster.	David A. Biscoe, Dudley.	Gilbert F. Pratt, Dudley.
Ware, No. 164,	L. B. Sanford, Ware.	E. W. Barney, Ware.	F. H. Doane, Ware.
Hampden, No. 165,	Dr Geo. T. Ballard, Hampden.	Elizabeth S. Beebee, Hampden.	Mrs. A. J. Tuttle, Hampden.
Wellesley, No. 166,	Abel F. Stevens, Wellesley.	Geo. L. Chesbro, Wellesley Hills.	Martha L. Flagg, Wellesley.
Somerset, No. 168,	Geo. W. Rice, Pottersville.	Joseph Gibbs, Pottersville.	Mary A. White, Pottersville.
Lunenburg, No. 169,	Edwin S. Marshall, Lunenburg.	Hattie D. Stone, Lunenburg.	James Hildreth, Lunenburg.
New Braintree, No. 170,	H. L. Pollard, New Braintree.	Edwin L. Havens, New Braintree.	Emma A. Moore, New Braintree.
Merrimac, No. 171,	True Hoyt, Merrimac.	Frank E. Bartlett, Merrimac.	Alice J. Hoyt, Merrimac.
Ashby, No. 172,	C. C. Damon, Ashby.	Albert I. Hayward, Ashby.	Wm. J. Robinson, Ashby.
Hopkinton, No. 173,	Arthur Kyes, Hayden Row.	Emma E. Thompson, Woodville.	Arthur L. Fitch, Hopkinton.
Brookfield, No. 174,	Walter B. Mellen, Brookfield.	Mrs. A. G. Laflin, Brookfield.	Miss Cora B. Mitchell, Brookfield.
Athol, No. 175,	James F. Whitcomb, Athol Centre.	Mrs K. I. Oliver, Athol.	Mrs. M. J. Tooley, Athol Centre.
"Miller's River" of Orange, No 176,	Walter R. Phinney, Orange.	D. L. Crandall, Orange.	Ernest C. Stimpson, Orange.
Sturbridge, No. 177,	J. D. Underwood, Fiskdale.	Jennie S. Gilbert, Fiskdale.	C. E. Ainsworth, Sturbridge.
Monson, No. 178,	Omar Pease, Monson.	Mrs. C P. Keep, Monson.	E. M. White, Monson.
Ludlow, No. 179,	F. E. Sikes, North Wilbraham.	A. L. Bennett, Ludlow.	Grace A. Bennett, Ludlow.
West Brookfield, No. 180,	Windsor R. Smith, West Brookfield.	C. S. Johnson, West Brookfield.	Jennie C. Preston, West Brookfield.
Westport, No. 181,	Marcellus Boynton, Central Village.	Mrs. Emma F. Potter, Central Village.	Miss Susie Harrison, Westport.
Southbridge, No. 182,	Geo. L. Clemence, Globe Village.	Wm. H. Eccleston, Southbridge.	Wm. C. Cady, Southbridge.
Andover, No. 183,	Milo H. Gould, Andover.	Edward W. Burtt, Andover	Mrs. Carrie A. P. Gould, Andover.
Topsfield, No. 184,	Wellington Donaldson, Topsfield.	B. J. Balch, Topsfield.	Mrs. Lillie Donaldson, Topsfield.
Fitchburg, No. 186,	– – –	Miss Jennie R. Rice, Fitchburg.	Miss Jennie M. Hills, Fitchburg.
"Satuit" of Scituate, No. 187,	Geo W. Griggs, Norwell.	Mrs. Geo. Cushing, Norwell.	Chas. O. Ellms, Greenbush.
Littleton, No. 188,	Chas. F. Watts, Littleton Common.	Mrs. A. H. Nelson, Littleton.	Susie F. Wing, Littleton.

Warren, No. 189, . . .	Fred N. Lawrence, Warren.	Wm. L. Day, Warren.	Alfred A. Warriner, Warren.
Bellingham, No. 190, . . .	Dr. N. W. Sanborn, Bellingham.	Mrs. Annie White, Bellingham.	John J O'Sullivan, Bellingham.
Chestnut Hill, No. 191, . .	Everett E. Southwick, Mendon.	Mrs. Minnie Irons, Millville.	Mrs. O. M. Aldrich, Millville.
Winchendon, No. 192, . .	Walter Smith, Winchendon.	W. W. Holman, Winchendon.	Ardella E. Gregory, Winchendon.
Foxborough, No. 193, . .	Edwin Moultrop, Foxborough.	James W. Alden, Foxborough.	Aurelia L Buck, Foxborough.
Townsend, No. 194, . . .	T. E. Flarity, Townsend.	Emma F. Gates, Townsend.	G. A. Wilder, Townsend.
Royalston, No. 195, . . .	C. A. Stimson, Royalston.	Mrs. C. A. Stimson, Royalston.	Mrs. L. H. Woodbury, Royalston.
Easton, No. 196, . . .	Wm. N. Howard, South Easton.	Edward B. Maglathlin, South Easton.	Mrs. Willis B. Drew, South Easton.
"Brookville" of Holbrook, No. 197, ...	Edw. E. Bowen, Holbrook.	Mrs. J. Capen Howard, Brockton.	Miss Mabel E. Bard, Brookville.
Leominster, No. 198, . . .	C. H. Currier, North Leominster.	C. H. Rice, Leominster.	F. K. Page, Leominster.
Stoughton, No. 199, . . .	I. H. Lamb, Stoughton.	M. F. Farrell, Stoughton.	Roby M. Gilbert, Stoughton.
Uxbridge, No, 200, . . .	Chas. E. Crocker, Uxbridge.	Mrs. G. Z. Taft, Uxbridge.	Mrs. C. B. Davis, Millville.
Bridgewater, No. 201, . .	H. F. Worrall, Bridgewater.	Mrs. Susan L. Harden, Bridgewater.	W. M. Black, Bridgewater.
Ashburnham, No. 202, . .	Walter H. Laws, Ashburnham.	Joseph H. Cogswell, Ashburnham.	Henry W. Holman, Ashburnham.
Westminster, No. 203, . .	A. E. Hurd, Westminster.	Mrs. Wm. W. Sterlin, Westminster.	L. Ashton Sawin, South Westminster.
Rowley, No. 204, . . .	Willard P. Smith, Rowley.	W. A. Foss, Rowley.	S. D. Carlton, Rowley.
"Webster" of Marshfield, No. 205, ...	Israel H. Hatch, N. Marshfield.	Georgie M. Damon, North Marshfield.	Celia J. Wilson, North Marshfield.
Hanover, No. 206, . . .	Lot Phillips, West Hanover.	W. G. Park, West Hanover.	Mrs. Hattie I. West, N. Pembroke.

ANNUAL REPORT

OF THE

BOARD OF CATTLE COMMISSIONERS

IN ACCORDANCE WITH SECTION 51 OF CHAPTER 491 OF
THE ACTS OF 1894.

JANUARY 10, 1895.

REPORT

OF THE

STATE BOARD OF CATTLE COMMISSIONERS.

To the Honorable Senate and House of Representatives.

In accordance with the requirements of section 51 of chapter 491 of the Acts of the year 1894, the Board of Cattle Commissioners beg to present the following report of their work for the year 1894.

In the report which this Board presented to your honorable body in January of last year, which report was printed as House Document No 50 of that year, we recommended, among other things, further legislation in relation to the perfecting and codifying the laws in relation to the suppression of contagious diseases among domestic animals. That report was referred to the joint committee on agriculture, and the Board was requested, by them, to prepare a draft of a bill embodying the suggestions made. Such a bill was drawn by this Board and submitted to the committee at a public meeting held by it on February 7, and was printed as House Document No. 207.

A large number of public hearings were given by the committee on agriculture upon the matters contained in the bill submitted by this Board, and upon other bills relating to similar matters submitted by other persons. All of the points suggested in the various bills were carefully gone over in public hearings, and were fully discussed by every person who desired to express any views upon the matter; and the several bills were most carefully and exhaustively examined by the committee, who reported, March 22, 1894, a bill embodying, with some slight changes, which will be hereafter referred to, the bill submitted by the commission. The reported bill was printed as House Document No. 803. This bill, after being thoroughly considered by both branches of the Legislature, became, with some slight clerical changes, a law, by receiving the approval of his Excellency the Governor on the 20th day of June, 1894, and was enacted to take effect upon its passage. The law is chapter 491 of the Acts of the year 1894.

Immediately upon the passage of the act the Board undertook the organization of the work required by the new law. It first printed a pamphlet edition of the act, and distributed it to the city and town authorities, to all the inspectors and to other interested persons throughout the Commonwealth, and copies of the same were furnished to all persons who desired them. Many copies were sent to the proper authorities of various States, in response to numerous requests.

Under section 36 of this act the Board of Cattle Commissioners was increased from three to five members, and it was felt by the then existing Board, that, in view of the importance of the work before it, no important steps should be taken until the new commissioners had been appointed. The old Board, however, undertook the preparation of drafts of letters of instruction, blank forms of returns, records and other similar matter called for under the act.

On the twenty-sixth day of June his Excellency the Governor sent to his council the name of Frederick H. Osgood of Brookline, to be a member of this commission for the term of three years, and the name of Leander F. Herrick of Millbury, to be a commissioner for the term of two years. Both of these appointments were confirmed by the governor's council on the third day of July. The newly appointed commissioners accepted their duties and took the oath of office. Dr. Osgood joined the Board at a meeting held by it on July 12, and Mr. Herrick on July 19.

At these meetings the Board prepared and approved letters of instruction to the city and town officers, the several Boards of Health and the inspectors appointed under the act, upon the duties thereby imposed upon them. At the same and subsequent meetings the Board examined and adopted the several forms of letters that had been prepared, the blank forms for the use of the inspectors in making the necessary returns and records of their doings, and all other forms incident to carrying out the provisions of the new act, copies of all of which are appended hereto.

In accordance with the requests received by this Board from several of the cities and towns, a form of application and permit for license to slaughter neat cattle was also prepared and approved. In order to secure uniformity in the keeping of these records and the making of returns, the Board prepared and caused to be printed all of these various forms, at the expense of the Commonwealth, and furnished them without charge to all the proper authorities.

In 1876 an act was passed providing for the appointments of inspectors of provisions and animals intended for slaughter, which law was substantially embodied in chapter 58 of the Public Statutes. This was a permissive act, simply providing that the mayor and aldermen of cities and the selectmen of towns *may* annually appoint one or more persons, who *may* inspect all provisions and animals intended for slaughter. Under this act, which was taken advantage of by the cities and towns only slightly, it was found to be impossible to organize any systematic inspection of the herds of cattle in the State, and in 1892 (chapters 195 and 400) the law was so amended as to provide that the same authorities "*shall* annually in the month of April appoint one or more persons to be inspectors of provisions and of animals intended for slaughter, or kept for the production of milk." Under this latter act, however, no penalty was provided for the failure of the cities and towns to make the appointments required by the act, and it was found necessary to again strengthen the law. Accordingly, in 1893 (chapter 306) a penalty was provided for cities and towns failing to appoint inspectors as required by law, and further, the inspectors were, by this act and for the first time, brought under the partial control of the Cattle Commissioners, by giving the Board the right to make appointments where cities or towns failed to do so, and the power to remove incompetent inspectors.

This latter act was approved May 3, 1893, and immediately after its passage this Board undertook to collect the names and addresses of the various inspectors; to instruct them in their duties, in so far as they related to the matter of the suppression of contagious diseases among the domestic animals; and to see that, so far as possible, animals intended for slaughter or kept for the production of milk were inspected as thoroughly as circumstances would permit.

The first attempt to collect the names and address of the various inspectors was begun on May 12, 1893. Up to about Oct. 15, 1893, only about one-half of the cities and towns in the Commonwealth had complied with this requirement; so that upon Oct. 27, 1893, the Board issued a further order in relation to the matter, a copy of which may be found in the report of last year (House Document No. 50). At the time the report of this commission was made, last year, two hundred and seventy-nine cities and towns had appointed inspectors in accordance with the law, and seventy-three had failed to report.

From this small beginning, and in the face of many discouragements, the organization of this corps of inspectors has been developed, until now all but four of the cities and towns have made the necessary appointments. Up to the passage of the law of last year the interest among the inspectors in their work was far from uniform; since the passage of that act considerable interest in the work has been manifested by them and by most of the cities and towns throughout the State, — so much so that it was determined to hold a convention, at which all of the inspectors might meet with the commission and with each other, in order that they all might have a better understanding of the work which was being done throughout the State.

The commission accordingly called a convention, which was held at Worcester on Thursday, the twenty-fifth day of October last past. This convention was attended by two hundred and ten inspectors, representing one hundred and fifty-three cities and towns. In addition to these inspectors and the commission, there were present the secretary of the State Board of Agriculture; several members of the last Legislature; the Hon. J. H. Walker, member of Congress from Worcester; representatives of the sanitary live stock boards of various States; the veterinary adviser of the Dominion of Canada, Prof. D. McEachran of Montreal; veterinarians and many others interested in the work, — a number reaching to fully three hundred in all. Hon. Henry A. Marsh, mayor of the city of Worcester, extended a cordial welcome to all of those who were present. The meeting, although the first of its kind ever held in this State, was very successful and profitable to the commission, and, it is hoped, to the others who were present. A report of the proceedings is appended hereto.

Shortly before the close of the last session of the Legislature the commission received a letter from the State Board of Live Stock Commissioners of Illinois, requesting the Commonwealth to send representatives to a convention proposed to be held at

Washington, D. C., during the month of June, which was referred to his Excellency the Governor, who instructed the secretary to co-operate with the other boards in holding such a meeting. This convention was held on June 19, 20 and 21, at the Department of Agriculture in Washington; and Hon. Levi Stockbridge, chairman, and Dr. Charles P. Lyman, secretary, of this Board, were directed by his Excellency to attend the convention on behalf of this Commonwealth. Many interesting subjects were discussed; among them tuberculosis, glanders, and the matter of obtaining uniform State laws for the suppression and prevention of the spread of contagious and infectious diseases among domestic animals. The papers on the subjects and the discussions following them covered, in a very interesting and instructive way, many of the questions in which this State is now deeply interested. Among them there was a consideration of the best methods of obtaining co-operative action in the several States between which an interchange of domestic animals is naturally and more or less constantly taking place; the best methods of handling and suppressing outbreaks of glanders among horses; and, incidental to the matter of stamping out contagious diseases, a consideration of the subject of indemnifying the owners of animals that are seized and destroyed for the public good.

On the subject of tuberculosis two valuable papers were presented; that of J. H. Kellogg, M.D., of Battle Creek, Mich., is a very exhaustive consideration of the subject from a sanitary stand-point, discussing as it does, among other things, the existence and extent of disease among mankind and among neat cattle, the activity of its contagious principle and the methods by which it is spread. The second paper on the subject, by M. R. Trumbower, V. S., of the Sanitary Live Stock Board of Illinois, is an interesting and instructive discussion. The remarks of Dr. D. E. Salmon, chief of the Bureau of Animal Industry, which followed these papers, are especially worthy of attention. All of these papers and remarks contain a fund of valuable information upon this subject. A copy of the proceedings of the convention is appended to this report.

Prior to September 1 of this year all inspections of animals suspected of being tuberculous were conducted by this Board upon the basis of a physical examination, and the results had been far from satisfactory, — so much so, indeed, as to convince them of the entire futility, and danger even, of relying further upon this method for determining the presence of that disease in neat cattle.

While the Board, as a board, had been proceeding in this way, Drs. Lyman and Osgood of the Board had been making a long series of experiments with tuberculin, for the detection of tuberculosis among this class of animals; and upon September 20 Dr. Osgood presented the result of these investigations to the Board. In view of this reported experience, the Board were satisfied that the use of tuberculin was a reliable method of detecting the disease among neat cattle; and that the time had arrived at which a more scientific method should be used, both for the protection of the owners of cattle and the public, in properly determining the existence of this disease; and that a plan should be adopted, if possible, for the substitution of the tuberculin test in place of the physical examination, which had been heretofore uniformly used. In order to do this, it was felt that not only should animals as reported by the several inspectors be tested with tuberculin, but that systematic regulations should be promulgated and enforced throughout the State for quarantining animals until tested; for regulating the importation of animals from without the State; for providing a market, as at Watertown and Brighton, at which tested animals might be purchased by those desiring to have them; and for the systematic examination of all neat cattle throughout the State. After a most thorough and careful consideration of the matter at this meeting, Commissioner Osgood was requested by the Board to formulate a definite plan for the accomplishment of these purposes. The report of this commissioner was submitted to a full meeting of the Board, held on October 4, and was adopted by a unanimous vote. The system then adopted embraced: —

First. — The test, with tuberculin, of all suspected cases reported by the local inspectors.

Second. — The regulation of the importation of all neat stock into this Commonwealth from all points without its limits.

Third. — The quarantining of all such imported animals until tested with tuberculin, and either condemned or certified as sound.

Fourth. — The establishment of regular quarantine stations, at which all animals brought within the limits of the Commonwealth should be delivered in quarantine.

Fifth. — The forbidding of the importation of all neat stock within the limits of this Commonwealth, unless delivered at these points except upon written permit to the Board.

Sixth. — The branding, in a distinct way, of all animals that had successfully passed the tuberculin test.

Seventh. — A systematic examination, by the use of tuberculin, of all animals within the State, beginning with the counties of Nantucket, Dukes and Barnstable.

The first announcement of this policy was made at the convention held at Worcester, the 25th of October; and subsequently the Board, upon November 20, issued orders and regulations covering the same, to take effect upon the twenty-fifth day of November, a copy of which orders will be found appended hereto.

Prior to the adoption of the tuberculin test by the Board, as the best known method of examining animals suspected of being affected with tuberculosis, the work of the commissioners in relation to the examination of cattle consisted in keeping a corps of inspectors throughout the State in as perfect a condition as circumstances would permit; instructing them regarding the interpretation and enforcement of the law, as far as it applied to their duties in inspecting animals and slaughter houses, or otherwise in connection with the commission; in directing the times at which the examinations of herds should be made; and in keeping proper records of the results of the work done by them. Besides this supervisory work, in all cases of animals reported by the several inspectors, or by other persons, as suspected of being affected with a contagious disease, the several members of the Board made a personal examination of the suspected animals so reported, reliance always being placed upon physical examination; and, as a result of such examination, each animal was either condemned as diseased or freed from quarantine and certified as sound. In addition to this, the Board, as far as possible, inquired into such breaches of the law as came to their attention, and took such steps as were necessary or practical to prevent their occurrence in the future.

Upon the adoption of the orders, which took effect on the 25th of November, a very great addition was made to the work of the commission. These duties may be subdivided into four distinct heads: —

First. — The attending to the inspection of all animals reported by the local inspectors as suspected, and the testing by tuberculin of all such as are reported to be tuberculous.

Second. — The quarantining of all neat cattle which are delivered at the quarantine stations at Watertown, Brighton or Somerville, and the testing with tuberculin of such of them as are not to be immediately slaughtered at the Brighton Abattoir, or which are not to be immediately transported to points without the limits of this Commonwealth, which calls for a weekly service extending over three days.

Third. — The systematic examination with tuberculin of all herds within the State, which includes the test by tuberculin, the destruction of all deceased animals, the disinfecting of the contaminated premises and the branding of all animals found free from disease.

Fourth. — The granting of permits for the transportation of animals from without the limits of this Commonwealth to various points within the State, where they are immediately quarantined, and the testing of the same with tuberculin in the same manner as already described.

The detail of this work and its result is fully described in the latter portion of this report.

On the first day of October of this year the term of office of Hon. Levi Stockbridge, who had been the chairman of this commission for many years, expired. At a meeting of the Board on September 25, Professor Stockbridge announced that he had tendered to his Excellency the Governor his resignation as commissioner; and his long service on the commission ended with the appointment of Charles A. Dennen of Pepperell to be a commissioner for the term of three years.

The Board desire to express their appreciation of the careful, conscientious work which Professor Stockbridge has done, both actively in the field and by his influence in shaping legislation for the suppression of contagious diseases among the domesticated animals in this State. Professor Stockbridge was first appointed cattle commissioner by Governor Bullock, in August, 1868, and, through all the changes that have taken place in this commission, he has served continuously as chairman of the Board from that time until his resignation was accepted. By the withdrawal of Professor Stockbridge the commission feel that they have lost the services of a valuable man, — on account of his great experience in the work which the commission is doing, on account of his faithful attendance to his duties, on account of his genial disposition, and on account of the great confidence which he inspired in the agricultural community and in all others with whom he came in contact in his work.

Upon the eighteenth day of October his Excellency the Governor sent to the council the name of Charles A. Dennen of Pepperell, to be a commissioner for the term of three years. His appointment was confirmed by the council on the twenty-fifth day of October, and immediately thereafter Mr. Dennen took the oath of office and entered upon the duties of the office. On the same day the resignation of Professor Stockbridge was accepted Commissioner Dennen was first present at a meeting of the Board held on October 30, and at this meeting the vacant chairmanship was filled by the unanimous election thereto of Dr. Frederick H. Osgood.

Taking up now the several classes of work referred to heretofore, we submit here, first, a report upon the work of the local inspectors throughout the State and the work of the commission in connection with the same.

Under section 1 of chapter 491 of the year 1894, it is provided that the mayor and aldermen of cities and the selectmen of towns shall within thirty days after the passage of this act, and thereafter annually in the month of March, appoint one or more persons to be inspectors of animals and provisions. These inspectors are selected by the town and city officials, and receive from the city or town of their appointment such compensation as may be by them decided upon. Under the provisions of this section there have been appointed, by three hundred and forty-nine cities and towns, three hundred and ninety-four inspectors. While these inspectors are required to carry out and enforce all orders and regulations of the Board of Cattle Commissioners or any of its members, they are not in any sense the appointees of this Board, nor is the Board generally consulted in the matter of their selection. The power is given to this Board to appoint such inspectors when the cities or towns fail to make the appointment; and the Board is further given the power to remove any inspector when, in its opinion, the inspector neglects or refuses to be sworn, or properly perform the duty of his office, and in such case the Board is given the right to appoint another inspector in his place. While this power is vested in the Board, it has not as yet been exercised, and therefore the inspectors throughout the State to-day are city or town appointees.

In 1894 it was demanded for the first time that the general occupation of the inspectors should be forwarded to the Board, together with the name and address in each case; and it may not be without interest in this connection to give these. So far as they have been received, they are as follows: —

Farmers,	136
Veterinary surgeons,	58
Cattle dealers,	10
Butchers,	8
Doctors of medicine,	20
Health officers,	4
Grocers,	3
Provision dealers,	2
Traders,	2
Painters,	2
Chief of police,	2
Cow doctors,	2
Blacksmiths,	2
Keeper,	1
Occupation not given,	124
Wood and coal dealers,	5
Retired sea captain,	1
Meat peddler,	1
Cabinet maker,	1
Market gardener,	1
Insurance agent,	1
Carpenter,	1
Stone mason,	1
Street commissioner,	1
Electrician,	1
Lumber dealer,	1
Truckman,	1
No occupation,	1
Grain dealer,	1
Total,	394

The work of the inspectors in connection with the Board of Cattle Commissioners may be divided into two classes: first, the examination of animals for the detection of contagious disease; and, second, the inspection of carcasses of animals which have been slaughtered under the provisions of the law. In regard to the examination of animals throughout the State, their work may be again divided into two classes, — that in relation to neat cattle and that in relation to other animals. It is the duty of the inspectors, under the act, to make "regular and thorough inspection of all neat cattle within the limits of their several cities and towns." These inspections are made in such a manner and at such times as the commission designates. In the circular letter of "Instruction to Inspectors," which was issued by the commission soon after the passage of the present law, it is ordered "that two thorough examinations of all neat cattle be made in each year, — one during October, or as soon as possible after the animals come in from pasture; the other during March, or just before the animals are turned to pasture; they are also ordered and advised to make inspections of any herds, or of any animals, within their district, whenever any emergency arises, or whenever in their judgment it is better for them to do so." Under this order the inspectors throughout the State made examinations from time to time of suspected animals up to the time of the regular fall inspection. This was begun about the 1st of October, and up to December 15, at which time the returns were required to be sent in, reports had been received from 243 towns, covering the examination of 131,968 animals.*

In addition to this regular work, a new duty was imposed upon the inspectors under the law of 1894, requiring them to make, from time to time, inspections of all other domestic animals within the limits of their several cities and towns whenever they have knowledge or reason to suspect that such animals are, or have been, exposed to any contagious disease. Of these inspections the commission receive no returns except in cases where the animal has been quarantined as suspicious. Upon making all inspections of neat cattle, it is the duty of the inspector, if in his opinion the animal is free from contagious disease, to deliver to the owner or person in charge a certificate of its wholesome condition. Copies of the form of this certificate will be found appended hereto. Under this provision, up to December 15, there had been issued by such inspectors certificates of soundness of 21,273 herds, all of the certificates, of course, being based upon the physical examination by the inspector. Wherever an inspector suspects, or has reason to believe, that any animal inspected by him is affected with a contagious disease, it is made his duty to immediately quarantine the suspected animal, he being given the power to do so. This power was first given under the law of 1894; prior to that, all quarantines had to be imposed either by the Cattle Commission or some of its members, or by the local boards of health. This machinery was found cumbersome, in that it required local boards to act as a board; and also practically defective, because the local authorities treated the inspector as the agent of the Board, whereas he was an independent officer; and consequently most quarantines imposed were found to be imperfect. The change in the law of last year has been found to be very beneficial in correcting this evil.

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* The total number of neat cattle assessed in the State in 1894 is: cows, 182,477; other than cows, 41,059; total, 223,536.

The method of imposing quarantines was also changed by the law of 1894, which required, for the first time, that the quarantine should be in writing; that a copy of the order should be delivered to the owner or person in charge, or left at his last and usual place of abode, or that the same should be posted upon the premises; thus leaving no room for doubt in the mind of the owner as to whether or not his animal had been placed in quarantine. Whenever the inspector imposes a quarantine, it is his duty to immediately send an exact copy of the order to the Board of Cattle Commissioners, and to notify the local board of health, at the same time, of the establishment of the quarantine; this gives a double check upon the work of the inspector; and this copy returned to the commission, with the statement upon the reverse side, by the iuspector, showing the method of imposing the quarantine, is in itself good evidence in any tribunal that a quarantine had been properly imposed. In this way the work of quarantining has been thoroughly systematized. Under this power, prior to December 15, the inspectors have imposed quarantines and made returns of the same to the Board as follows: neat cattle, 2,584; horses, 230; swine, 25 herds.

While the inspectors are given the power to impose quarantines, they are not given the power to remove them; all such quarantines can only be removed by order of the local boards of health or by the cattle commissioners. In addition to the power given to the inspectors to impose quarantine, the local boards of health have similar powers. The boards of health have not generally been called upon to exercise this power except in a few instances where horses suspected of being glandered were concerned.

Upon the receipt by this Board of a notice of quarantine upon any animal, it becomes the duty of the commission to act in the matter. In view of the great mass of work coming under this head, the Board soon found that the matter of inspections, by them, of suspected animals, could not be efficiently performed unless some regular system was adopted; they were therefore obliged to establish the rule that the commissioners should only act in the matter of inspecting suspected cattle where the animal had been quarantined by the proper authority. This rule was arrived at not only because of the large number of cases which called for their personal attention, but also from the fact that, unless the animal was securely quarantined, they were liable, upon arriving at the place where it had been located, to find that it had been removed or that it was otherwise beyond their reach, — this has occurred many times after travelling long distances.

Prior to October 4, the existence of the contagious diseases in these animals was determined by the commission upon a physical examination; and, as before stated, in the cases of tuberculosis the results were found to be exceedingly unsatisfactory both to the commission and to the owners of the animals. The symptoms were so unevenly shown that animals which were apparently sound were released, and in some cases afterwards found to be affected with the disease; in others, animals which appeared to have the symptoms of the disease were, after slaughter, and upon post-mortem examination, found to be free from tuberculosis, but affected with bronchitis, pneumonia or other non-contagious disorder; and in this way throughout the State a large number of mistakes occurred, notwithstanding the fact that the greatest care was taken to prevent them. In fact, we were simply repeating the experiences of all other countries that had tried to do anything towards the removal of tuberculous animals from among its herds, and we felt that the ultimate result was sure to be extremely unsatisfactory to all parties concerned; and consequently, as has already been stated in this report, the Board determined to adopt the uniform rule of subjecting all animals suspected of being affected with tuberculosis to the tuberculin test.

The Board further felt, in view of the fact that the law passed last year provided for the payment of compensation to the owners of animals so slaughtered, and placed in the hands of the commission a considerable sum to be applied for this purpose, that, as representing the interests of the Commonwealth as well as those of the farmers and the people at large, it was, while pursuing this method, needlessly frittering away the State's money; because, while the State could, in the opinion of the Board, properly and justly expend large sums of money to *eradicate* this disease, any method based upon physical examination, as then pursued by the Board, would only result in the expenditure of a considerable sum without obtaining a result which was commensurate; for, while the commissioners might successfully pick out here and there throughout the various herds in the State animals where the disease was well marked, there were liable to be left in the same herds a large number of incipient cases, not capable of detection by ordinary means, and that therefore no efficient check to its spread would be made.

The Board, as has already been stated, determined, after a most careful and exhaustive consideration of the subject, and relying upon actual tests, to do away entirely with the physical examination, as a method of determining in the last instance the existence of the disease, and to substitute in its place the tuberculin test in all cases of neat cattle suspected of being affected with tuberculosis. Under this branch of the work no animal is so tested except where it has already been reported to the Board by a local inspector as tuberculous, and quarantined as such, — the inspector, of course, relying upon physical examination.

The other branch of the work of inspectors, in connection with this Board, relates to the examination, at the time of slaughter, of the carcasses of all neat cattle, including calves, that are butchered throughout the State. In the report which we submitted to your honorable body in January, 1894, we called your attention to the fact that tuberculous cattle were being slaughtered in different parts of the State by unprincipled butchers, and that the meat from them was being sold to unsuspecting persons for food. We then also stated that in our opinion this was one serious obstacle to the eradication of the disease, for controlling which no adequate provision of law then existed. We consequently recommended that some legislation be framed to control the matter of the slaughter of cattle, and providing for uniform inspection of the carcasses. In consequence of this, sections 17–23 inclusive of the Act of 1894 were passed, which provided briefly as follows: that all persons engaged in slaughtering neat cattle should apply to the mayor and alderman or to the selectmen for a license to conduct the business, which should designate the class of animals to be killed, the time at which the animals were to be slaughtered and certain other facts relating to the business. Upon receipt of this application, a proper license may be issued by the city and town authorities. It is then made the duty of the local inspectors to be present at the time of the slaughter of all neat cattle at such establishments, and to examine at that time the carcasses of all such animals. If the carcass is found to be free from disease, it is allowed to be sold; otherwise it is seized by the inspector and destroyed. In addition to this, provision is made for the inspection of all neat cattle slaughtered by persons not regularly engaged in the business, it being made their duty to cause the carcass of such animals to be inspected by one of the regular inspectors at the time of slaughter, "unless said animal has been duly inspected, under the provisions of this act, within six months prior to such slaughter, and a certificate of health has been delivered to the owner or person in charge thereof." The inspection herein referred to is the inspection by the local inspectors, which, as before stated, is based upon the physical examination, and under this provision more or less tuberculous meat will find its way into the market.

Under the provisions for licensing slaughter houses, there is nothing requiring that cities and towns shall make any return to the Board of Cattle Commissioners concerning the number of licenses issued; and the Board would recommend that the act be so amended as to require that each city and town shall, on or before the first day of June in each year, make a return to the Board of Cattle Commissioners, in such form as the Board shall provide, giving the names and addresses of the proprietor or proprietors of every slaughter house, canning, salting, smoking or rendering establishments, or of every establishment used in the manufacture of sausages or chopped meat of any kind, which are engaged in the slaughtering of neat cattle; and the names and addresses of all of such as have made application to slaughter neat cattle, and the names of all of those to whom licenses have been issued.

In General Order No. 1, issued by the Board this year, all inspectors were directed to make regular monthly returns, showing the number of animals that had been examined at the time of slaughter, the number which had been found to be free from any contagious disease, the number condemned and the causes of the condemnations. All the information which the commission now have as to which towns have complied with this section of the law is based upon the returns made by the inspectors in conformity with this order. Up to December 15 the inspectors in 164 of the towns and cities had made returns, showing that 39,072 had been examined, 236 of which were condemned as being affected with tuberculosis.

In all cases where tuberculosis was found present, so far as the commission is informed, the carcasses have been destroyed or disposed of otherwise than for food, as the law requires. As this portion of the law is entirely new, the commission has not felt that it was wise to vigorously push prosecution for breaches of its provisions, although in some cases, where offences have been flagrant, prosecutions have been successfully maintained.

This whole division of the work, coming from the local inspectors, entails upon the commission an amount of labor which has been as great, if not greater, up to the present time, than that in any other branch of their duties. The returns have to be examined and tabulated; suspicious animals visited, examined and disposed of under the law, as each occasion demands; numerous interviews must be held with inspectors and town officers, coming from all parts of the State; innumerable letters are received connected with the special work, to many of which careful answers must be given covering particular and peculiar cases; and in many other ways the efforts of this large corps of inspectors must be directed.

Before leaving the matter of the inspectors, it should be said that they are also given the power to inspect meats, fish, vegetables, fruits or provisions of all kinds throughout the limits of their city or town, and also of veal found, offered or exposed for sale within such limits. This work of the inspectors is conducted entirely in connection with their local boards of health; and, while it may form a more or less considerable portion of their work, it is not brought under the supervision of this commission, and consequently they can not make any statements as to the nature and extent of this work.

In addition to the large corps of local inspectors appointed throughout the State, the Board also has under its control a corps of agents, directly assisting them in their work of examining suspected cattle. Under section 43 of the act the Board is given the power to "appoint from time to time such officers, agents or assistants as are necessary or expedient to carry out the purposes of the act."

Prior to the adoption of the tuberculin test by the Board, this power was not exercised by the commission. As soon, however, as they determined to use this test, it was found necessary to have a corps of skilled assistants, especially drilled in the method of using tuberculin, in order that the returns upon which the Board are obliged to act should be as accurate and reliable as it is possible to make them. They have accordingly, from time to time, appointed agents and assistants for this work, until upon December 15 there were thirty-three such agents and assistants so appointed and employed by the Board, who receive, while actually engaged in the work, their expenses and a compensation varying from $1.50 to $5 a day.

At the time of the adoption of the tuberculin test, as the proper method of examining all animals suspected of being tuberculous, the Board were of the opinion that, while its efforts in this direction, as based upon the mere examination of animals reported by the inspectors to be tuberculous at isolated points throughout the State, would result in the destruction of actually diseased animals to a considerable extent, it would be of but little service in really cleansing the herds of the State from the disease; because the animals so examined and selected for the test were only such as appeared to show external symptoms of the disease; and also because the Board felt, from its experience with the test, that other animals, apparently healthy, were being allowed to go free and spread the contagion. Thus in the end the percentage of diseased animals would be but slightly decreased.

They were further impressed with the fact that not only were the public interested in the destruction of diseased animals, but the farmers and dairymen were equally interested in having, if possible, some means of assisting them in their purchase of cattle, so that they might be able to replace the animals destroyed with others which had successfully passed the test.

The Board, therefore, felt that the best method of protecting all parties and eradicating the disease was only to be obtained by a thorough scientific examination of all neat stock throughout the State. They therefore decided to begin a systematic examination of all animals in the State, county by county; taking proper precaution, as fast as all the animals in each county had been examined, destroyed or marked, to prevent, by quarantine regulations, the importation within its limits of animals which had not already been so examined.

In determining where they would begin this work, they took into consideration the natural conditions of the State; and, feeling that the seaboard formed of itself a practical quarantine from the importation of animals, they determined to begin with counties bordering on the sea. They first, therefore, selected Nantucket, Dukes and Barnstable. The reason which led to the selection of these counties, only, in their first order, was that they are comparatively small, contain but few animals, presumably as healthy as any in the State, and that the small appropriation would be practically exhausted by the time the examination of the cattle within these limits could be completed.

Accordingly, as a part of their general order of November 20, which is hereto appended, they issued General Order No. 5, relating solely to those counties. This order briefly quarantines all neat cattle within the counties until examined, requires that all the cattle within the limits shall be subjected to the tuberculin test, and forbids the bringing into these counties any neat stock which has not been branded by the commission as free from tuberculosis.

This order was imposed at the same time the State was quarantined, and the regular systematic examination and branding of cattle at Brighton, Watertown and Somerville was introduced. In this way, not only were these counties freed from the disease by the eradication of all sources of contagion within their limits, but at the same time the inhabitants of these counties were furnished with a market where they could be sure of purchasing animals which have successfully passed the tuberculin test. At the time of making this report the commission have completed the examination under this order of all animals in the island of Nantucket, and they are very glad to say that the result in the island has been very satisfactory; that of six hundred and sixty-five animals examined only six have been found diseased, and this disease was found in the bodies of animals which had either been imported to Nantucket from the main land or in those that had been in cohabitation with such animals; and that, while the farmers had lost so few cattle, it has apparently resulted in a considerable increase in the value of their stock, as the cattle there are now held at prices nearly thirty-three per cent. higher than before this examination was begun.

The field work was placed in charge of Commissioner Dennen, who with a corps of eight assistants went to Nantucket, and, after conferring with the local inspector, divided the island into sections, selected for convenience, having due regard to the distribution of the cattle as far as could be ascertained. The examination of every animal on the island was then proceeded with, following minutely the detail given in this report under the head of the tuberculin test.

One of the main difficulties which has been met with by the commission is that of obtaining a sufficient number of competent men to perform the work in the field. The Board has always followed the plan of selecting only such persons as are thoroughly competent, and who have had considerable previous experience in the application of the test. It should be remembered that a carefully conducted post-mortem examination is made upon the body of every animal which is condemned and killed; and the Board are very happy to say that these examinations have demonstrated the high quality of the work performed by these agents.

The commission has heard complaints from time to time that not only were they subjecting the animals to a new and unusual test, but that they were being condemned by men of inexperience, and that the owners were suffering from the mistakes of these agents. An examination of the method pursued by the Board will show to any such persons that these complaints are without foundation. Not only is the greatest care used, as already stated, in selecting the agents to apply the test, but in no case have the agents passed upon the existence of the diseases or condemned the animal as a result of the test. These agents simply tabulate the result of their own work, and in all cases this is examined and checked by the commission, the existence of the disease being always determined by it, and the condemnation order issued by some one of its members.

Brighton and Watertown.

The Board, as a part of this systematic endeavor to stamp out tuberculosis in the State, has also undertaken to regulate the sale of neat stock brought within its limits, so as to insure, as far as circumstances permit, that such cattle are free from tuberculosis.

The animals which are brought into this State for sale are delivered here in two ways; a majority of them, in the opinion of the Board, are brought in by the several transportation lines, the larger proportion being delivered at the markets at Watertown and Brighton. In addition to these there are, of course, a considerable number of cattle driven into the State on the hoof, to be delivered at various points, concerning which, up to November 25, there were no records.

As far back as 1892 this Board were in receipt of frequent reports that neat stock brought to the Brighton and Watertown markets for sale within a very short time thereafter showed themselves to be tuberculous, and so, worthless for beef or dairy purposes; although it was claimed that the buyers of this stock had paid good prices, and had endeavored, as far as circumstances would permit, to ascertain their soundness before sale. The Board was requested to examine into the matter, and ascertain if it was not possible for them to establish some system for the protection of those desiring to buy such stock, so that they might be assured, as far as possible, that the stock so purchased by them in this market was free from tuberculosis. The Board, recognizing the reasonableness of this request and the importance of the work, has made every possible endeavor to assure the health of the animals sold at these markets. The matter was referred to in the report filed by this commission last year; and again the commission desire to state that they have been greatly assisted by the hearty co-operation of the Board of Health of the city of Boston and the town of Watertown.

Prior to the report of last year, both of these boards appointed a special inspector, to be at these markets and examine all cattle offered for sale thereat. In addition to this, at the request of this Board, during the early part of the present year, the Board of Health of the city of Boston appointed an additional inspector at Brighton, to assure the prompt and thorough examination of the stock; notwithstanding which this office continued to be in receipt of complaints from buyers that the neat stock purchased at these markets was still found to be more or less tuberculous. It had been therefore pretty thoroughly demonstrated to the satisfaction of this Board by something more than two years of actual experience that the health of the stock sold thereat could not be determined to any appreciable degree by means of physical examinations.

With the adoption of the tuberculin test the Board determined to inaugurate if possible some practical method, whereby all of the cattle coming to these markets should be subjected to that test before being offered for sale. Whether or not, in view of the circumstances under which these animals have to be examined, such a result can be obtained by the tuberculin test still remains to be proved.

In connection with this use of tuberculin at these markets, it should be remembered that the test is a purely scientific method of determining the existence of the disease by measuring the reactions caused by its injection, as shown by the temperature of the animal at given periods after the inoculation.

In the case of an animal under normal conditions, where it is free from excitement, where it is only being fed at the times designated by the person applying the test, where it is allowed to drink water only under the same circumstances, — in fact, where all conditions are entirely within control of the examiner, the temperature table shows a regular and consecutive variation, which can be relied upon to determine the result. Like every other scientific test, experience shows that a manifold number of unforeseen conditions may come in to complicate the result; and it is only after a careful study of these conditions and a thorough consideration of the effect produced by them that their values can be eliminated in arriving at a satisfactory result. The whole experience of the commission with tuberculin has shown this to be true; and they have found that, while animals under a normal condition, when subjected to this test, will always show a well-defined result, upon which the existence or the non-existence of the disease can be practically demonstrated, other animals, when subjected to abnormal conditions, will so far vary the results as to materially complicate the problem of determining the existence of the disease.

This scientific method, it must be remembered, is comparatively new; and, while it has been carefully studied in its normal aspects and under more ordinary conditions, the nature and effect of abnormal conditions cannot as yet be thoroughly tabulated. Hence it is that while in the opinion of this Board tuberculin is a reliable test under ordinary conditions, extraordinary conditions, frequently unknown to the person applying it, so far complicate the matter as to cause errors to creep in to a certain extent, which errors, in the opinion of the Board, are not due to the tuberculin, but to the unappreciable circumstances. While this agent as a test of the existence of tuberculosis has been used to a considerable extent by other scientists and boards doing the same work, under normal conditions, but little is known as to the effect upon it of the abnormal conditions met with at these markets; and the Board cannot, therefore, rely upon the researches of others, but must depend entirely upon its own experience in the field in giving to these extraneous circumstances their proper place in determining the result in any given case. There has been no field where the effect of the environment has been so much felt as in the matter of the application of this test to neat stock brought into the stock yards at Brighton and Watertown.

The cattle which are sold at these markets are not resident cattle, but are brought to it from more or less distant points, a great proportion of them coming from without the limits of the Commonwealth. As these cattle are brought there for the purpose of sale, it goes without question that they are not delivered at the market except at as near to the time of sale as circumstances will permit, the owners not desiring to incur any unavoidable expense for care and food. The commission have therefore endeavored to arrange that the quarantine shall cover the shortest possible period of time that an application of this test will permit. These cattle are collected from different localities and brought together for the first time. They have been put into crowded cars, have suffered the excitement attending an unusual journey, have probably received their food and water at irregular periods, and in every possible way have been subjected to conditions utterly foreign to their ordinary existence. Neat stock are not mere machines, but are excitable animals, materially affected by unusual conditions. Another significant fact in relation to the cows brought to these markets is that they generally are or are about to be new milch; and it is within the knowledge of all who have had practical experience in this direction that this greatly increases their nervous sensibilities, and experiment shows that this actually has a direct effect upon their internal temperatures. Added to this is the fact that great popular interest has been shown in the matter of the tests applied at Brighton or Watertown, and that consequently at the time when these animals are being examined there is usually a large crowd of interested and curious people present, who are anxious to thoroughly understand the test and its working in the field.

Although the commission, even with its slight experience, has recognized the fact that the presence of these spectators has to a greater or less extent rendered it more difficult to obtain satisfactory results, they have felt that the public should be accorded every opportunity to witness their methods and the effect of tuberculin upon the animals subjected to the test; and they have, therefore, accorded to all persons who desired every reasonable opportunity to watch the proceedings throughout their several stages. An examination of the tests at these markets has proved to the satisfaction of the commission that all of these abnormal conditions have very materially complicated the temperature tables, as a result of which they have made a few mistakes in arriving at their conclusions.

The first test of cattle at Brighton and Watertown, under the circular of November 20, was made upon the twenty-first day of November, and has continued weekly since that date. The examinations begin about Tuesday noon and continue until Thursday evening of each week, the entire time of Commissioner Herrick being given to this work in the field upon these days, as is a portion of the time of two other commissioners. Another full day of Commissioner Herrick's time is consumed at the office in attending to the business resulting from those examinations. In addition to this, the Board employs some ten or twelve assistants in performing the tests and in the various parts of the work.

The result of the work at these markets is shown in the following table: —

Brighton, Watertown and Somerville.

	Nov. 21.	Nov. 28.	Dec 5.	Dec. 12.	Dec. 19.	Dec. 26.
Number examined, . .	270	187	194	308	303	170
Number condemned, .	26	25	16	18	14	11
Number tuberculous, .	23	18	8	17	13	10
Number not diseased, .	3	7	8	1	1	1
Number held for re-test, .	1	1	3	5	19	10

An examination of this table, covering the first six weeks of the work and bringing the matter up to the time of writing this report, will show that about 6.21 per cent. of all animals offered for sale at the markets have been shown to be tuberculous. It will also be seen that in judging of the healthy condition of 1,432 animals 21 mistakes have been made, as proved by post-mortem examinations; and that fewer errors of this sort occurred in the last three weeks than during the earlier experiences. For themselves, the commissioners feel that, in view of the facts that have been given regarding the conditions under which the examinations have been made, these results are not by any means discouraging.

By this system of examination of all neat stock at Brighton and Watertown the commission have practically reached all of the cattle brought into this State by the regular transportation companies. As has already been stated, there are other animals brought in from time to time, records of which, up to the establishment of these orders, could not be obtained. As to these animals, the Board required, as a part of General Order No. 3, that every person desiring to bring neat stock into Massachusetts from points without its borders should obtain a special permit; and further, that as soon as the animals had crossed the line and had arrived at the point designated they should be placed in quarantine, there to remain until subjected to the tuberculin test. Under this provision the Board has issued 17 permits for 166 animals. All of the animals which have entered the State under these permits have been placed in quarantine and examined. All were found free from tuberculosis.

In considering all the statistics based upon the work resulting from the general orders of November 20, it must be remembered that they have been in practical operation but a short time, and that the figures are based upon not more than about one month's experience.

Summary.

Whole number of neat cattle reported by inspectors and by others under section 29, chapter 491, Acts of 1894,	3,295
Whole number of neat cattle examined at Brighton, Watertown and Somerville,	1,432
Whole number of neat cattle examined in Nantucket,	665
Total,	5,394

Of these all were examined with tuberculin, as a result of which there were found tuberculous —

From inspectors and others, 810, or about 24.58 per cent.
From Brighton examinations, 89, or about 6.21 per cent.
From Nantucket examinations, 6, or about .9 per cent.

In considering these results, it should be remembered that among the first lot are a great number of animals that were selected by the inspectors, upon physical examination, as being suspicious, so that it is not right to consider the per cent. indicative of the probable extent of tuberculosis among the herds of the State.

The figures coming from the examinations made at the markets are valuable, for they show, almost absolutely, the whole number of the diseased animals; and they are the first reliable statistics of the kind ever obtained, so far as we are aware, under any similar conditions.

Nantucket is the only part of the State that has as yet been examined, herd by herd, taking in all of the animals. The results are exceedingly satisfactory, but, inasmuch as the animals here are naturally isolated, the result cannot be considered as an indication of the average percentage of the disease in the rest of the State.

"TUBERCULOSIS."

Tuberculosis in cattle is a subject of equal importance, not only to the agriculturist but to the public generally. Its eradication from the animals from which we derive so large a portion of our nutrition is of the utmost importance from the standpoint of public health. The insidious nature of the disease has much to do with the comparative slowness with which professional and public attention has been directed to it.

In the middle ages tuberculosis in animals was recognized as contagious, and laws were passed prohibiting the use of the carcass for food, which laws have remained in force in Italy and Spain up to the present time. In the sixteenth century it was confounded with syphilis, and at the end of the eighteenth century with glanders. The propagation by contagion in herds was recorded in Germany by Ruhling in 1774 and by Krunitz in 1787, and more recently by Spincla, Zanngers and others. In France the same was claimed by Fromag, Huzard, Lafosse, Dupont and Crucel.

The manifest tendency of the disease to run in families, and to develop under special unwholesome conditions of life, serves to weaken the belief in contagion, and in central and western Europe such belief had become practically extinct among medical men, when their attention was recalled to the subject by scientific inoculation of tuberculosis in rabbits and guinea pigs by Villemin in 1865.

No practical addition to our knowledge of the disease was made until Koch discovered in 1882 the bacillus tuberculosis, since which the identity of the disease in man and animals has been fully established.

PREVALENCE.

Owing to the facts that up to within a very short time we have been unable to make a reasonably sure diagnosis, and that we have had no systematic inspection of our abattoirs and slaughter houses, there are no available statistics as to the prevalence in our immediate vicinity. All we can do is to reason by analogy from such statistics as are obtainable. The following abattoir statistics, showing the percentage of tuberculous animals, are of value in this connection: Prussia, 6.3

per cent.; Berlin, 12 per cent.; Dresden, 14.4 per cent.; Bromberg, 26.2 per cent.; Upper Silesia, 9.5 per cent.; Midlothian, 20 per cent.; Yorkshire, Eng., 22.8 per cent.; Durham, Eng., 18.7 per cent.; London, 25 per cent.

In England, during an outbreak of contagious pleuro-pneumonia, extending over a period of sixteen months (1890–91), there were slaughtered as being affected, or having been exposed, 12,000 animals, all of which, under the direction of the department of agriculture, were subjected to a critical post-mortem examination by skilled veterinary surgeons for the purpose of ascertaining the prevalence of tuberculosis, from which were derived the following results: cows, 16.09 per cent.; bulls, 1.53 per cent.; cattle over one year, 2.77 per cent.; cattle under one year, 1.2 per cent. Of the 12,000 examined, 12.2 per cent. were found tuberculous. In some herds the rate was as high as 75 per cent., and only a few herds were entirely free. Earl Spencer's herd of Jerseys, containing twenty odd animals, were tested by tuberculin, and all reacted. Post-mortem examination of the entire herd confirmed the diagnosis. (Report P. H. Brice, M. S. (P.).)

At a recent conference of the sanitary association of Scotland, Professor Wright presented estimates that tuberculosis in cows causes an annual loss to the owners of dairy stock in Scotland of £440,000 sterling, or $2,200,000. (Veterinary Journal, page 391, November, 1893.)

Professor Jansen of Tokio Veterinary School, in his report of the contagious diseases of the domestic animals in Japan, says it has never been witnessed among domestic cattle, though it prevails among those imported into the country, especially in the Devons, Ayrshires, Americans and their crossings with the indigenous breed. According to the abattoir statistics, he says fifty per cent. of the American cattle and their crossings are tuberculous. (Flemming's Journal, page 45, January, 1894.)

Any reliable estimate of the percentage of tuberculous animals in a given area can not be given, for reasons before mentioned; but that it exists to an alarming extent none deny. From our experience the percentage is variable in different herds, bearing a direct ratio to the surroundings and conditions under which such animals have been perpetuated and kept. In one instance a herd of five cows, kept especially to furnish the children with a pure milk supply, all reacted, and the post-mortem examination showed that they were tuberculous. In a herd of sixty-four animals, carefully selected, and kept under apparently the best conditions for a private milk supply, sixty of the sixty-four reacted, all of which were killed, and the post-mortem examination confirmed the correctness of the diagnosis.

In the	examination of	a herd of	23	animals	17	were condemned.
"	"	"	15	"	5	"
"	"	"	9	"	3	"
"	"	"	93	"	14	"
"	"	"	21	"	7	"
"	"	"	21	"	19	"
"	"	"	28	"	10	"
"	"	"	17	"	11	"
"	"	"	10	"	2	"
"	"	"	26	"	3	"
"	"	"	25	"	3	"
"	"	"	67	"	12	"
"	"	"	22	"	13	"
"	"	"	15	"	5	"
"	"	"	9	"	9	"
"	"	"	39	"	14	"
"	"	"	39	"	24	"
"	"	"	33	"	4	"
"	"	"	64	"	40	"
"	"	"	38	"	30	"
"	"	"	103	"	19	"
"	"	"	63	"	53	"

Upon post-mortem examination all were found tuburculous.

We have had numerous other instances where in large herds of cattle the percentages have averaged from 100 per cent. down.

The following table, prepared by "Rockl," is of interest in this connection: of 51,427 cattle slaughtered in 1888–89 in abattoirs and butcher shops in Germany, the percentage of infection according to age was as follows: up to six weeks old, 0.6 per cent.; from six weeks to one year, 0.6 per cent.; from one year to three years, 11.4 per cent.; from three years to six years, 33.1 per cent.; over six years, 43.4 per cent. (Report of P. H. Brice, M.D., to the Provincial Board of Health, Toronto, page 25.)

The prevalence of consumption in the human being is so well recognized that it is not necessary to set down here, at length, any statistics. The mortality of human beings throughout the world from all causes shows of the entire death rate one in every seven is from consumption. While this is the general average throughout the world, statistics show that this rate is greatly increased in special occupations and among special classes of people, and further shows that the denser the population the greater is the percentage of deaths from tuberculosis.

An excellent table of this sort has been prepared by Dr. Lagneau in the statistics of 662 cities in France, which show that the closer the people are packed together in cities the more frequent is this disease. These tables show the number of persons annually dying from consumption out of every one thousand inhabitants in cities of different populations as follows: —

95 cities with less than 5,000 inhabitants, ...	1.81 per cent.
332 cities of between 5,000 and 10,000 inhabitants, .	2.16 per cent.
127 cities of between 10,000 and 20,000 inhabitants, .	2 71 per cent.
50 cities of between 20,000 and 30,000 inhabitants, .	2.88 per cent.
46 cities of between 30,000 and 100,000 inhabitants, .	3.05 per cent.
11 cities of between 100,000 and 430,000 inhabitants, .	3.65 per cent.
Paris, with 2,224,704, inhabitants, ...	4 91 per cent.

This table shows that this disease is more frequent where the population is denser, and where, therefore, the inhabitants are subjected to poor sanitary conditions.

PUBLIC HEALTH.

The danger to the public health from the prevalence of tuberculosis in our neat cattle is due to the fact that when the flesh or milk from such animals is consumed by man it may, by the introduction of the germ, transmit the disease.

Direct experiment with the milk or meat of tuberculous animals cannot be made upon man, but such, however, have been made upon the lower animal, conclusively showing its infectious character. Among many hundred that have been made the following may serve as an example: —

Hiershberger inoculated rabbits in the abdominal cavity with the milk from thirty-nine tuberculous cows, in which the udder was sound, and produced tuberculosis in fourteen cases. Bangs inoculated from sixty-three tuberculous cows, selected for their sound udders, and found the milk of nine of them infected. A careful microscopic examination revealed tuberculosis in the udders of three of the cows, leaving six that gave infected milk, in which, even after death, and with all scientific appliances, no tuberculosis could be found in the udder. Another case is recorded where the owner of a very valuable herd of cattle, finding that a large proportion of them were tuberculous, withdrew his milk from the market and used it for fattening his pigs, of which he had a large number. The result was that the pigs, almost without exception, became so infected with the disease that it was necessary to slaughter the whole herd.

An example of this came under the direct observation of the Board, where thirteen animals were quarantined on a farm removed from all other animals, and which had responded to the tuberculin test. These animals were used for experimental purposes during the past eight months, among which experiments one was the feeding of milk to four calves, which had been demonstrated to be free from disease, by the test. The calves have since been slaughtered and found to be tuberculous.

The communication of the disease from cattle to man can only be shown by accidental cases, many of which have been recorded. Doctor Treom describes the poor, emaciated, diseased animals furnished to the tribes of north-western Indians, — how they eat the liver, tallow and entrails, raw and fresh, and how the carcass is dried, pounded, packed in skin to be eaten later uncooked, even though these animals died of disease. The Indian mortality of consumption is fifty per cent. of all deaths, at several points; while at Crow Creek, Dak., fifty out of the total Indian population of twelve hundred die yearly of consumption and scrofula. (1 Amer. Practitioner, quoted by Law, *ibid.*, page 131; 2 Holder, Medical Record, Aug. 13, 1892, quoted by Law, *ibid.*, page 131. Scrofula is usually of tuberculous origin. L.) Dr. Washington Matthews spent twenty-one years among the Indians. He states that their food is the primary cause of tuberculosis among them, and that when the supply of fresh beef is liberal the death rate from consumption is highest. (Census of 1880.)

The question of infection of tuberculosis being conveyed by the milk is often of even greater importance than is infection by flesh. Doctor Brush, who is a physician and cattle breeder, in his paper on the "Coincident geographical distribution of dairy cattle and tuberculosis," read before the New York State Medical Society, Feb. 5, 1894, calls attention to the fact that in lands like Egypt the indigenous inhabitants retain immunity while associating for a long time with consumptive immigrants; while on the other hand, in regions like Australia and the Sandwich Islands the inhabitants have become infected after the introduction of dairy cattle. The best dairy cattle breeds, he argues, are the tubercular breeds, while others not classed as dairy cattle are exempt from tuberculosis, owing to their vigor and health. Again, in all dairy countries the prevalence of tubercular consumption is a settled fact, while the only countries at all in doubt are those where the dairy products are supplied from other sources than our domestic cow. Referring to China, he spoke of the pure Chinese as a people who did not use milk, while the Tartars in that country were meat and milk consumers; and therefore the observations of medical men are confusing, and they confess that they cannot understand why the disease prevails among the dominant Tartar class, and not among the poorer Chinese, who, according to all preconceived notions, ought to be tubercular. The doctor then contrasts the conditions in Spain and Morocco, where the climatic conditions are about the same: "Morocco, where there are no European dairy cows, is exempt from tuberculosis; while in Spain and Portugal, where dairying is carried on in the European style, tuberculosis prevails."

The danger from the use of meat of tuberculous animals is small in comparison with the danger from milk, owing largely to the fact that beef before being eaten is subjected to a greater or less degree of heat, whereas milk is taken largely in its natural form, and is used generally in the uncooked state. This, however, cannot be said of all the products of the dairy, the butter and cheese being fully as dangerous as the milk. To what extent the milk of tuberculous animals contains the bacilli of consumption is an exceedingly difficult question. One fact is, however, absolutely certain, that the bacillus has not infrequently been found in such milk. Reasoning from this stand-point, we must believe that the danger is considerable with milk from tuberculous cows, and should never be used. Numerous experiments have been made by scientific observers, proving that the milk is often affected, even though the disease has shown no localization in the milk glands.

Hirschberger experimented with the milk from twenty tuberculous cows, and in fifty-five per cent. of all the samples experimented with he found the bacillus of tuberculosis.

Dr. Demme records the case of four infants in the Child's Hospital at Berne, the issue of sound parents, without any tuberculous ancestry, that died of intestinal and mesenteric tuberculosis, as the result of feeding on the unsterilized milk of tuberculous cows. They were the only cases in which he was able to exclude the possibility of other causes of the disease, but in these he was satisfied that the milk was alone to blame. (Law: Cornell University, Experiment Station, Bulletin 65, page 137.)

The infant son of a college mate of one of us, a comparatively strong and healthy child of twenty-one months, visited his uncle for a week. While there he drank the unsterilized milk of a cow which was soon after condemned and killed in a state of generalized tuberculosis. A few weeks after his return, the child began to fail, and died three months after the fatal visit, a mere skeleton, with tabes mesenterica, or consumption of the bowels. Both of the child's grandfathers had died of tuberculosis when over sixty years of age, as well as two grand-aunts and one grand-uncle. The child never saw but one of these, and him but two or three times, and for short intervals only. A second child brought up on sterilized milk is in robust health. Both parents are in excellent health. (Private letter to J. L. H.; also reported by Law, *ibid.*, page 137.)

In the practice of Dr. Stang of Amorback, a well-developed five-year-old boy, from sound parents, whose ancestors on both sides were free from hereditary taint, succumbed after a few weeks' illness, with acute miliary tuberculosis of the lungs and enlarged mesenteric glands. A short time before, the parents had their family cow killed, and found her the victim of advanced pulmonary tuberculosis. (Law: Cornell University, Experiment Station, Bulletin 65, page 137.)

In the spring of 1890, Dr. Gage, city physician of Lowell, Mass., had as a patient an infant which died of tubercular meningitis. Its parents were healthy and surroundings good.

It had never been fed on anything but the milk of a single cow. The cow's milk was microscopically examined, and found to contain the bacillus tuberculosis. Guinea pigs inoculated with her milk developed the same disease. A second child fed upon the same milk was developing symptoms similar to those discovered in the child that died. Dr. Gage could find no way to prevent the sale of the milk, unless he bought and paid for the cow out of his own pocket. So far as he knew, she was still being used as a milk supply a year later. (Ernst: Hearing before Committee on Public Health, Mass. Leg. of 1891; Publications Massachusetts Society Promotion Agriculture, page 19.)

May 30, 1879, a cow died of generalized tuberculosis in Providence, R. I., the lungs, most of the abdominal viscera, muscular tissue and udder being tuberculous. The milk had been used in the family. In August the baby was taken sick, and died in seven weeks of tubercular meningitis. Post mortem showed tubercular deposits in the membranes covering the brain and some in the lungs. Two years later a two-year-old child in the same family died of tubercular bronchitis; and seven years later a nine-year-old boy, "delicate" for years, died of "quick" consumption. So far as known, the family on both sides were rugged and healthy. (Ernst: Report to Massachusetts Society Promotion Agriculture.)

Olliver, at a meeting of the Academie de Medicine of Paris, stated that a patient of his, a young woman twenty years old, of vigorous health and without constitutional trouble, had acute tubercular meningitis (inflammation of the membranes of the brain, of tubercular origin). She had been educated at a boarding-school where thirteen pupils had been ill with, and six had died of, tuberculosis within a few months. The milk supplied to the school was from cows kept on the place. Upon examination, these animals were found to have tubercular ulcers upon their udders, and after being slaughtered were found to be generally tuberculous. (Bacteriological World, August, 1891, translated from Allgem. Med. Cent. Zeit.; also La Semaine Medical, Paris, Feb. 25, 1802.

Tuberculosis localized in the mammary gland is of not uncommon occurrence in cattle. Milk from such animals is found to contain the bacilli, and is capable of producing the disease.

Unlike other affections of the mammary gland, tuberculosis does not at once change the appearance and quality of the milk secreted. It is a fact that for months after the disease has appeared in the gland the milk is to all appearances normal, and may be sold and consumed without arousing the least suspicion. Authorities are, however, not fully agreed as to whether the milk from tubercular cows in which the udder is not involved should be considered dangerous; but the results of experiment have been positive in a large number of cases where no recognizable disease of the udder was manifest.

Professor Ernst and Dr. Peters, from the result of their experiments, conducted under the most exacting conditions and with every possible precaution against contamination, found that the proportion of positive results in a lot of cows affected with a high degree of general tuberculosis was eighty per cent.; in a lot affected with only a moderate degree, sixty-six per cent.; and in a lot in which the disease was localized in the lungs, thirty-three per cent.

The bacilli could only be demonstrated microscopically in one specimen of the milk, showing that inoculation experiments are the most certain guide as to whether the milk is infectious or not. In conclusion Dr. Ernst says: —

First, and emphatically, that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease.

Second. — That there is no ground for the assertion that there must be a lesion of the udder before the milk can contain the infection of tuberculosis.

Third. — That, on the contrary, the bacilli of tuberculosis are present, but with no discoverable udder lesions.*

In Bulletin No. 3 of the United States Bureau of Animal Industry (1893) is the report of the inoculation of guinea pigs with milk from six tuberculous cows, where the udder was not visibly diseased, in which positive results were obtained in two cases and negative in four. J. J. McKenzie reports forty per cent. contained bacilli in animals where no lesions could be found in the udder by post-mortem examination.

Some authorities, however, still contend that the udder is diseased when the milk is infected, but that the disease escapes observation. However this may be, if such is the case, the mere fact that the udder may be diseased and the disease not recognizable simply casts suspicion upon all milk from tuberculous animals. When we consider, therefore, the prevalence of tuberculosis among our cattle, and take into account the hidden character of the disease, a certain amount of suspicion rests upon all milk while these conditions exist.

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* Many of the preceding examples are collected in Vermont Bulletin No. 42.

The State Board of Health of New York, in its recent report on this matter, says: —

> There can no longer be a reasonable doubt that tuberculous cattle are extensively distributed through the dairies of the State, forming centres of infection in their respective herds; that the milk from such cattle is bad, and, in many cases, though not acting perniciously upon all who partake of it, is still sufficiently dangerous to warrant as earnest precautions and as effective prophylactic measures as in the case of small pox, typhoid and cholera.

While this Board does not for a moment contend that animal tuberculosis is the main cause of consumption in the human family, it is, however, an element of danger that should be removed.

The Tuberculin Test.

As so many descriptions of tuberculin and the method of using it as a diagnostic agent in tuberculosis among neat cattle have been recently published by the agricultural experiment stations throughout the various States and in the newspapers from Maine to California, it hardly seems to be desirable in this report to give a minute description of its nature and manufacture.

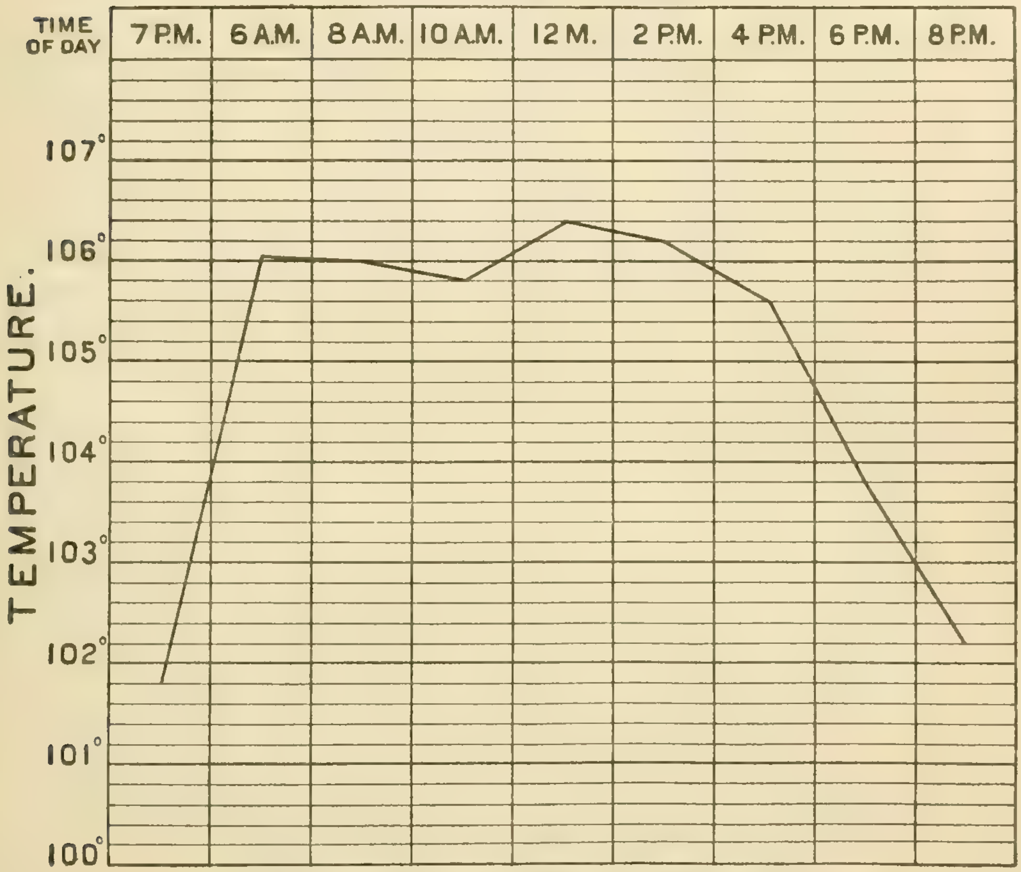
Briefly speaking, tuberculin is a product of the bacillus tuberculosis. It is prepared by making what is known in the laboratory as a pure culture of the bacillus in a proper fluid medium. These cultivated bacilli are allowed to grow for a certain length of time, during which they produce their peculiar product, which is known as tuberculin. This tuberculin mixes with the medium in which the bacilli have been grown, and at this stage the fluid is sterilized, that is to say, it is subjected to a temperature of 212° F. for a sufficient length of time, to absolutely kill any germs that may be in it. The mixture is then put into a porcelain filter, which is not unlike a rather large candle in appearance. The contents of the filter are then, in a proper way, subjected to an exhaust pressure of sufficient force to strain the purely fluid parts of the contents out through the porcelain. This filtered fluid does not contain any of the bacilli. The fluid is next properly evaporated, which drives off the surplus water and concentrates the tuberculin. When this concentration reaches a certain point the fluid is carefully bottled, under conditions which absolutely prevent the introduction of any germ, in order that it may be kept unchanged. When the fluid is to be used it is properly diluted to a certain standard and again carefully bottled.

In making the test, a very small quantity of this tuberculin is injected under the skin of the animal, three drops of the concentrated tuberculin, or thirty drops of a ten per cent. solution, from whence it immediately enters the blood. Experience has shown — and this is the value of the test — that if this very small dose is injected into an animal which already has tuberculosis, it is sufficient to produce a fever in the animal; that if the animal is free from tuberculosis, — that is, if the living bacilli of tuberculosis are not in its system, — the dose injected is not sufficient in quantity to make any impression whatever, and is promptly eliminated.

Whether or not the fever has been created in a given animal by the tuberculin is demonstrated by the proper use of the clinical thermometer and a careful study of the tabulated results obtained; and so accurate are its results, that we have been able to make hundreds of consecutive examinations upon animals, under ordinary farm conditions, without a single error.

Our method of making the test is invariable: a sufficient number of preliminary examinations are made with the thermometer to ascertain accurately the normal temperature of the given animal, these examinations being made at, as nearly as possible, the same time of day in all cases. The normal temperatures having been ascertained and recorded, the injection of tuberculin is made in the evening. Eleven hours after the injection we commence taking and recording the trial temperatures. These are taken each two hours until the test is finished. The time required to properly complete this part of the test varies considerably; it may roughly be stated at from six to thirty hours, with an average of about twelve hours. It may be of interest to show the behavior of the thermometer in one of these cases, as recorded upon the clinical chart such as is commonly used in the work of this Board. Such a chart is as follows: —

CLINICAL CHART.



THE INJECTION WAS MADE AT 7 P.M.

This animal was condemned and found tuberculous.

Inquiry is frequently made as to how many degrees of rise are considered to surely indicate the presence of the disease in a given animal This question is one that cannot be easily answered in an off-hand way, and it is not safe to condemn an animal unless the temperature table has first been carefully studied. The reaction caused by the tuberculin is so plainly marked in by far the greater number of the cases *under the usual conditions*, that the animal may be condemned or released with absolute certainty, *providing the necessary care has been observed in making up the table.* On the other hand, a careful study of the tabulated tests appended to this report will show the exact nature of many of the difficulties and the complexity of some of the problems submitted to the examiner. While the testimony of those who have had the most experience in using tuberculin, as a diagnostic agent among neat cattle, is universally and emphatically in its favor, there are those who, upon the slightest sort of experience or upon theoretical grounds, or upon no grounds whatever, condemn it as being so uncertain in its action that it is practically useless; and they advance the most senseless arguments to defend this position, as, for example, "Koch, when he invented tuberculin, did not intend it for this work, but as a cure for consumption in human beings." This is true; but when it was being used for this purpose so largely, just after its discovery, it was noticed that in every consumptive patient to which the agent was administered there was a decided rise in temperature after a few hours.

This fact was seized upon by Professor Gutman of the Veterinary Institute of Dorpat, Russia, who experimented with the agent on cattle, and found the high reaction in tubercular *animals* to be fully as constant; since which time tuberculin has been used with almost uniform satisfaction in the detection of tuberculosis in cattle. "Bollinger says tuberculin is a most valuable aid to diagnosis in the case of cattle suspected of tuberculosis." (London Veterinary Journal, February, 1891.)

Satisfactory results have been reported by the imperial sanitary office of Berlin, by the Toulouse Veterinary School and by the Copenhagen Veterinary School.

The Belgium minister of agriculture issued a circular Nov. 22, 1892, giving official sanction to test inoculation for tuberculosis. Professor Dukerhorf says: "The results are absolute and gratifying, and show that tuberculin is a reliable agent for determining the presence of tuberculosis in cattle." (Journal Comparative Medicine, October, 1892, page 637.)

The conclusions arrived at by the Paris Congress of 1893 for the study of tuberculosis were: "That, notwithstanding the negative results, which are happily very rare, it is an undeniable fact that the use of tuberculin constitutes by far the best means of detecting the existence of tuberculosis in the domestic animals." (Page 411, F. Journal, December, 1893.)

The value of tuberculin as a diagnostic agent in our own country is vouched for by the Bureau of Animal Industry, Professor Law of Cornell, Professor Pierson of the University of Pennsylvania, Drs. Peters, Faust and Cooper Curtis, inspectors for the New

York State Board of Health, and J. J. McKensie of the Provincial Board of Health. The experiment stations of Canada, Vermont, New York, New Jersey, Pennsylvania, Virginia, Wisconsin and Minnesota have used it with convincing results. Quotations might be made from the reports of many investigators, American and foreign; but the following, taken from the Vermont Bulletin No. 42, may suffice: —

"We shall now stop publishing reports on tuberculin in the Berlin Veterinary Weekly unless they contain some new facts or views. Since the publication of the reports of the extensive experiments of the royal health office, we may regard the question of the value of tuberculin in the diagnosis of tuberculosis of cattle as settled. The proof which has been presented to our readers is more than sufficient. The results are absolute and gratifying, and show that tuberculin is a reliable agent for determining the presence of tuberculosis in cattle."

It will therefore readily be seen that the use of tuberculin as a means of detecting the existence of tuberculosis in cattle has become general, notwithstanding the fact that for the purpose for which it was originally intended it has fallen into entire disuse.

It is only comparatively a few years (1882) since the fact was discovered and generally accepted that tuberculosis — that is, consumption — is a contagious disease, and that it is due in all cases to the presence of a particular germ, the bacillus tuberculosis.

Among people who have not given the matter of this disease any special study or attention, there is a misapprehension to a greater or less extent as to the nature of the disease and its contagion. In order that a given subject may become afflicted with tuberculosis, generally speaking, there must be two conditions; first, the presence of the bacillus; and, second, a receptive condition of the individual. No matter what the condition of the individual is, it is impossible to have the disease unless the germ is present. Practically speaking, it is also true that in a great majority of cases the presence of the germ will not produce the disease unless the subject is in a condition which is favorable to the germination of the bacillus. Because of the existence of the germ, we are enabled to determine, by the use of tuberculin, the presence of the disease in the individual.

While the commission, by destroying tuberculous animals, are removing the sources of contagion, and thus to a greater or less extent removing the dangers of causing consumption among human beings, from the very fact that this same disease exists in human beings, where the same methods cannot be pursued, no system for eradicating the disease can be perfect unless the other element in producing this disease is also considered and dealt with; that is, not only should the animals which are afflicted with this disease be destroyed, but methods should be adopted which shall reduce to a minimum the number of animals which are in the receptive condition.

Experience has shown that sound, healthy cattle may be in the presence of the germ without contracting the disease; whereas other animals, subjected to the same conditions and presumably not subjected to any greater amount of this contagious principle, have become well-marked cases of tuberculosis. The reason for this is plain that it is due to the condition of the animal exposed to the contagion. If, therefore, greater care is taken to preserve the general vigor of neat stock, it will have a very material effect upon the percentage of tuberculous animals throughout the Commonwealth. It must be remembered in this connection that, scientifically speaking, tuberculosis or consumption is, except in possibly extremely rare cases, not directly inherited. Theoretically speaking, therefore, every animal which is born, if the conditions are otherwise equal, is given an equal opportunity of escaping this disease; but the great difficulty with this is, that if the calves are born from tuberculous parents two conditions are apt to be present: first, that their organisms lack vigor, because the constitution of the parents has been sapped by the presence of this disease in them; and, second, because from the moment of their birth, when weak, not only from their inherited condition, but from the mere fact of their tender age, they are exposed to the influence of the contagious germs present in the body of the mother; hence it is that such a large number of cases of tuberculosis are apparently inherited, and hence the danger of breeding from tuberculous stock.

Another large class of tuberculous patients comes from the treatment of animals in dairies, due to not observing proper sanitary arrangements; not taking sufficient care as to the quality and quantity of the air which the stock is allowed to breathe; not giving them sufficient sun-light and exercise; feeding the animals with too large a quantity of stimulating grain, in order that the milk supply may be increased to its utmost limit; by too frequent breeding; and all causes of a like nature which tend to reduce the vigor of the parent stock. The reasons why the neat stock in this State is subjected to these conditions, which we have before referred to, is principally due to the fact that a large proportion of the stock in the State is kept for dairy purposes, where the owner desires to make them yield as large an annual profit both in milk and calves as possible.

Having this one object in view, and without a due consideration of the effect of this upon the health of the stock, the dairymen have been for years advised to treat the animals in the way before described. It is another noteworthy fact that tuberculous cows are exceedingly apt to yield large quantities of milk; and, as this is the object for which a great proportion of the cows are kept, it follows that the calves of these diseased animals are very apt to be the ones that are reared for future dairy purposes.

It is another fact of comparatively recent discovery, but of undoubted truth, that the use of milk and meat from diseased animals as food is a source of a probable large proportion of the consumption which exists in mankind.

The difficulties of the situation from the stand-point of the veterinarian have heretofore centred around the fact that many animals having every appearance of perfect health, with bright eyes, smooth coats, good appetites, giving large quantities of milk or putting on fat easily, — in fact, performing all their functions apparently perfectly, — were very frequently found in the slaughter houses or, when they died from accident, to be tuberculous; and it was a well-known fact that an animal might be tuberculous and still not present the slightest external symptoms of it to the most skilled observer. Under these circumstances, it was obvious that, in the light of the experience at that time, unless all the animals in the herd where tuberculosis was known to exist were killed, there could be no certainty that all of the centres of contagion in that herd would be removed.

These were the conditions at the time when the peculiar property of tuberculin, to which we have already referred, was discovered. In view of the manifold difficulties and errors which arose with the use of the physical test, it does not seem to be a good argument to say that tuberculin should not be used as a test because it is occasionally found to cause an error in the diagnosis; nor should this fact, if fact it be, be allowed to interfere with its general use in proper hands, as a means of identifying tuberculous animals. Any intelligent man must readily agree with the commission in thinking that it is better that an occasional animal which is free from the disease should be destroyed (as the law provides that when an animal is destroyed, and is found, upon post-mortem examination, to be free from the disease for which it was condemned, the owner shall receive a reasonable sum from the Commonwealth) than that many of those having the disease should be allowed to live to sow the germs of this incurable disease broadcast, not only among others of their kind, but among human beings. There is no doubt whatever that very many of the errors which have been charged to tuberculin should rather be placed to the lack of experience, errors in judgment, or the occasional carelessness of those making the tests. This is to be expected. It is an inseparable condition attending the situation, which, as the experience ripens and extends, will become a factor of less and less importance, because it will be of less frequent occurrence, and should be thoroughly considered before attempting to arrive at the conclusion that the remedy is valueless.

Before leaving the subject of tuberculin and its application in the field as a means of determining the existence of tuberculosis, it may be of value in this connection to consider some of the objections which have been raised against it.

The commission is not unmindful of the fact that the application of this test to the extent that it has been used in Massachusetts is comparatively new, that it has been used in localities throughout the State more or less scattered, and where the communities have not followed closely the several steps which have led up to its adoption, and they are, therefore, not surprised that its introduction into general use has met with diverse opinions as to its merits. The commission, however, is very glad to say that, as a whole, its adoption has met with popular approval; that by far the greater number of criticisms have been in favor of the method established; not only have favorable criticisms been met with throughout the length and breadth of this Commonwealth, but the matter has been followed out with keen interest in the adjoining States, and has there met the almost universal commendation. The criticisms have usually come from persons not having a full knowledge of the subject, or from those who, owning apparently healthy stock which have not indicated the slightest external symptoms of being tubercular, and which are apparently performing all the functions of their lives with at least their normal regularity, have had such cattle, after being tested with this agent, condemned and killed as tuberculous. It is not to be wondered at that such persons should look with considerable doubt upon the efficiency of an agent which was apparently robbing them of their property.

It is now proposed to briefly take up some of those objections to the use of tuberculin which have recently been put forward, and to answer the argument contained in them.

ARGUMENTS.

It is said, "The intelligent physician of to-day does not need tuberculin or any other drug to enable him to make a correct diagnosis of tuberculous disease in the human subject;" from which it is argued that there is no need to use the agent for this purpose in the bovine species.

This is a fallacious argument, for it is not true that the intelligent physician of to-day can in all cases correctly diagnose the existence of tuberculosis in the human being by means of a physical examination. Tuberculosis, whether in the human being or in animals, is a germ disease, and may be located in any organ or tissue of the body; it is true that in perhaps a majority of the cases the lungs are affected, and that it is a comparatively easy matter to diagnose a case of pulmonary tuberculosis. Under these circumstances, with a human being, the practitioner is able, by using the stethoscope, to accurately examine all parts of the chest and the action of the different respiratory movements at his own will; he has to deal with a voluntary agent, who is able to assist him in his work very materially. Such an agent can be directed to breathe in, to breathe out, to arrest the motion of breathing, to cough when he is asked, to make different sounds, and to otherwise exercise the functions of his lungs and vocal chords. In addition to this, it is a simple matter for the practitioner to obtain specimens of the sputum, which may then be easily subjected to a laboratory examination, that the presence of the bacillus may be determined; in other words, every facility is given to the practitioner to assist him in properly arriving at a conclusion. If, however, the seat of the disease is in other portions of the body, as, for instance, in some of the organs contained within the abdominal cavity, it is oftentimes very much more difficult to arrive at a positive diagnosis; in fact, cases have gone on for years, and have been treated by skilled practitioners for dyspepsia and other intestinal disorders, and not until after a post-mortem examination has it been known that the origin of the trouble was tuberculosis.

When, however, the examiner turns from the human being to the animal, an entirely different problem is presented. Here again actual experience has shown that it is only in a portion of the cases that the disease takes the form of pulmonary tuberculosis. Even in this case the examiner is met with a multitude of obstacles. He has not an intelligent voluntary agent to deal with, who can assist him in his examination by any of the methods before described. The examination of the lungs is made much more difficult because these organs are deeply seated, covered by large masses of flesh, and the whole body is closely covered with hair.

In addition to this, experience has shown that, while in a very large number of cases the disease is firmly established, yet the evidence of it in the lungs may be so slight as to make it impossible for the examiner, under the conditions presented, to detect its existence. In fact, the lungs of a neat creature must be very considerably diseased before the fact can be ascertained by physical examination.

The commission has found, upon post-mortem examination, animals with well-marked lesions of tuberculosis in various parts of the body, while the lungs were entirely free. An extremely instructive case of this sort was met with recently. An animal responded to the tuberculin test, and was condemned. Upon post-mortem examination the only lesion of the disease which could be detected was situated underneath the skin, deeply along the outer side of the left hind leg, extending from the gambrel to the pastern joint. Here numerous collections of the peculiar product of the disease were found scattered over the entire length described. In this case, for instance, it would have been impossible to pronounce the animal a case of tuberculosis had it not been for the tuberculin.

Another argument frequently adduced against the use of tuberculin is that the disease is not any more prevalent to-day than it was fifty years ago. What the conclusion is to be drawn from this statement, it is difficult to say. It is not claimed by the commission that the tuberculin is a proper agent because of the increased prevalence of the disease; but, even if the disease does not exist to-day any more than it did fifty years ago, there is no reason why every effort should not be made to seek out and remove that which does exist, now that science has placed means for doing so in our hands. In regard to the statement of the existence of the disease, as compared with fifty years ago, it is impossible to say whether it is true or false. No reliable statistics have ever existed, or do exist, to show the prevalence of this disease among animals; and it is only since the discovery of the peculiar faculty of tuberculin that the problem of eradicating the disease from among neat cattle could be seriously considered.

If tuberculin is as efficient as this commission, and others who have used it in large quantities, believe it to be, it simply puts in our hands an accurate means of determining the existence of the disease. As this agent has not been used before, and as its use has proved conclusively that the disease may exist to a marked extent in animals which show no external symptoms of it, it is not a proper comparison to place its declarations beside those coming from a simple physical examination, except to say that it is a much more reliable method in determining the existence of the disease.

Another argument used against tuberculin and the present policy of the State in endeavoring to eradicate the disease by the destruction of the centres of contagion, is contained in the statement that, "while tuberculosis was on the increase (in the bovine race), consumption, the same disease in the human race, was on the decrease."

In the first place, as there have never been any statistics, it is impossible to say whether or not tuberculosis is on the increase in the bovine race. We are simply finding more cases of it because we are using a better means of detecting it.

It is true, however, that in certain localities statistics show that the percentage of deaths from consumption in the human race are on the decrease. The cause for this decrease is apparent to any person who has properly studied the problem. Statistics show that the deaths from consumption in these localities (where statistics have been accurately kept) were for a certain time on the increase, and then within very recent years they began to decrease. This decrease was coincident with the adoption by boards of health and other proper authorities of the theory of the contagiousness of the disorder, and the consequent strenuous efforts made to eliminate this element of its spread by scattering broadcast among the people full information as to the better methods of preventing the extension of contagious diseases and of maintaining health. The fact that, with the adoption of this view and these methods, this most insidious disease has commenced to decrease in frequency, is most encouraging.

It is further stated (as an argument against the eradication of this disease by the methods adopted by the commission) that "In three of the Southern cities, where milk is used but little as a beverage, and consequently, to follow the arguments of the commissioners and scientists, the death rate from consumption should be low, it was 162 in Nashville, 144 in Charleston and 121 in New Orleans, — greater than in many of the largest milk-consuming centres of the North." This is based upon the erroneous supposition that it is claimed by this commission and those interested in this work that the source of consumption is in all cases directly traceable to the use of milk. This is one of the many sources of infection. It is a mere distributer of the germs of contagion, and, as has already been stated, in order to produce the disease there must be a receptive condition of the individual. Conditions of life in the South are far different from those in the North; and until all of the different conditions have been carefully studied and given their proper place in the consideration, the mere statement of the percentage of death rates within the limits of these Southern cities is of no value whatever.

It is further stated that "the germ or tuberculosis is possessed of great vitality, and the thorough disinfection of barns is an impossibility; as a result, as has already been the experience of some, when barns are restocked the disease will in all likelihood spread afresh. What use, then, in spending enormous sums of money and burdening the State with an expense that will not result in permanent good?"

No fair deduction can be drawn from these facts, because, until the new stock which are put into such barns have been proved to be free from the disease by the use of tuberculin or other proper method, which has never yet been adopted, it is impossible to say whether the existence of the disease in the stock is due to the germs contained in the building or is already in the body of the new animals which have been introduced.

It must be remembered that this work is comparatively new, and it has not been proved that it is impossible to properly disinfect buildings so as to remove the germs. Not only is the Board endeavoring to eradicate the sources of contagion by the destruction of the animals affected, but it is also endeavoring to disinfect the premises where the contagion has been found and from which all the diseased animals have been removed. As a matter of fact, within the experience of members of the commission it has happened that a large herd of cattle were examined with tuberculin; that a number of the animals, being all that were found diseased, were removed and killed; that the barns were thoroughly disinfected; and that the animals which had been destroyed were replaced from time to time by others which had been subjected to the tuberculin test, and found to be sound, before being allowed to enter the stable. After a period of nine months the entire herd was again examined with tuberculin, and not a single case of tuberculosis was found among them.

It has further been stated, by a person of some prominence in the veterinary profession, that "the real tuberculosis is only found in a few worn-out cows. For years such cows have been killed whenever found, and it does not necessitate any injection or other test to spot them. I venture to say that no cow that has been killed by the State agents for the past year has been a sufferer from tuberculosis."

If "the real tuberculosis is only found in a few worn-out cows," it is true that it does not necessitate any injection or other test to "spot them." Such cases are simple, and a person having no more than a small amount of skill may easily detect them by physical examination. That the statement is not true, however, will be at once granted by any person who has given this matter any attention, for they must be satisfied, as a matter of principle, that any germ disease must have its incipient and early stages.

As to the statement that "no cow which has been killed by the State agents the past year has been a sufferer from tuberculosis," statistics of the commission absolutely show its falsity. In the first place, up to the fourth day of October of this year all animals killed were condemned upon a physical examination; and yet this writer admits that tuberculosis may be determined by such physical examination. As to those which have been killed relying upon tuberculin as a test, any person who has followed out the work of the commission and has been present at the post-mortem examinations (which are always performed publicly) can attest to the incorrectness of this statement. The public are always offered every facility to be present at the post-mortem examinations; in fact, the owners of the majority of the cattle that have been killed have themselves, or through their agents, been present; and the commission is very glad to say that in all but a few of the instances it has been able to clearly demonstrate to the satisfaction of such owners, who are clearly the persons most interested in proving the inaccuracy of the test, that the disease has been present and sufficiently well marked to be recognized by the ordinary individual with the ordinary means of observation; and the commission has had in its experience many cases where it has been obliged to destroy neat stock of persons who were, up to that time, most hostile to the use of this test, who, having been present at the post-mortem examinations, and seeing for themselves the internal evidences of the disease, have become its strongest advocates.

Another argument against the use of tuberculin is a statement as to its inaccuracy, based upon the earlier work of this commission in testing animals brought into the Brighton and Watertown markets for sale. It is true, as has been shown previously in this report, that mistakes were made in condemning the animals there, based upon the tuberculin test; but this error was not due to tuberculin, but to other causes which have been already discussed.

Another argument adduced against the use of this agent is, "Some who are as good authority as any declare the injection of tuberculin to be dangerous, as well as useless." We have already shown that it is not useless in detecting the disease; that it is dangerous is yet to be shown by actual facts. With the thousands and thousands of doses of tuberculin that have been used in this way in this State and through this country and in Europe during the past four years, there is yet to come the first authentic account of any injury that has been done with it to healthy animals, when its use has been in competent hands. A statement of this importance should not be given weight unless it is accompanied with facts proving its accuracy. No such facts have ever yet been brought forward by any person; and these statements usually emanate from sources that have given the matter but little attention. An examination of the method by which tuberculin is prepared will show that it is impossible for it to produce the disease, and that it has not done so, the experience of the commission and many others in the field have clearly proved.

It is further said, "To kill a good, healthy cow, because it may have a small tubercle the size of a pea somewhere in the system, is worse than a blunder." Can it be said that a cow which is tuberculous, though there may be but "one tubercle the size of a pea," is a good, healthy cow, and incapable of disseminating the disease to others? Tuberculosis is a contagious disease, and if an animal has one tubercle in it, who will say that the blood is not already contaminated? Experience has satisfied this commission that there is but one course to pursue, and that is to destroy all of the animals in which tuberculosis is present, regardless of the degree.

It is further said that "The worst thing that can be said about the tuberculin test is that it is no judge *of the degree of the disease*, and that, while its indications are correct in a great majority of cases, it frequently says that the disease exists when it is in such an incipient form that the animals are apparently well and capable, under usual conditions, for many years of useful service." The use of the tuberculin is merely for the purpose of detecting the existence of the disease; in the opinion of the commission, the degree of the disease is of no importance. An animal where the disease is present is not capable, in the opinion of the Board, of *any* years of *useful* service. To be sure, it may live for years, it may perform its ordinary functions to a profitable extent, if the owner is allowed to sell its products, but it is nevertheless a source of menace to the health of the community. There is, therefore, but one course to pursue with such an animal, and that is to destroy it.

A great majority of the objections to the work of the commission in connection with the destruction of animals is based upon the question of what remuneration the owner shall receive for the animal destroyed. This question will be taken up at length in another portion of the report.

Milk from Tuberculous Cows.

One of the main purposes indirectly to be accomplished by the work which the commission is now doing in destroying tuberculous cattle is to purify the milk supply of the State. Some complaints have come to the attention of the commission in relation to the milk supply of the State in its relation to tuberculosis, which are worthy of attention. It is said, "Why, then, should the tillers of the soil be taken during their dull moments of toil and placed in the balances with the entire remainder of the State's individual wealth, and so be made to stand one-half the loss of their cows, and also taxed to help the State pay the other half, and at the same time allow any kind of milk sent into the State from other States for general family use? Is our tuberculosis any more deadly than that of Vermont or New Hampshire, or does Massachusetts owe her farmers a grudge, and intend to put them into the pauper list?"

So far as this complaint is intended to apply to the work of the Cattle Commission, they can only say that directly the whole matter is without their control. There is no law in this State which puts into the hands of the Board of Cattle Commissioners the right to regulate the sale of milk within this Commonwealth, whether such milk be derived from cows within the State, or whether it be brought, as milk, into the State, having been derived from cattle without its limits. The question of the regulation of the milk supply within this State, in connection with tuberculosis, is a matter worthy of the attention of your honorable body.

So far as this Board is aware, the only restrictions placed upon the sale of milk are those in connection with its being up to a certain standard in quality. This matter is entirely within the control of the boards of health, and the Board of Cattle Commissioners have nothing to do with it. There is no law in this State regulating the sale of milk from tuberculous animals, and no steps have been taken heretofore by the State to test milk sold in the markets for the purposes of ascertaining whether it contains the germs of tuberculosis; that such milk, derived from a tuberculous cow, may contain such germs, has been demonstrated beyond question; and that it thus may be a source of danger to the public health is equally true.

As a practical question, it is extremely difficult to ascertain surely in any given specimen of milk whether or not the bacilli are present. There are two methods used for testing milk for these germs, — one a microscopic examination of the milk, the other the inoculation of other animals, usually guinea pigs, with specimens of the milk, to see whether they will develop the disorder. It is impossible to test the milk of this State, in any appreciable quantity in comparison with the daily consumption, in either of these ways; and the only practical method of assuring the delivery of milk that is free from tuberculosis is to go to the fountain head of the matter, and see that the cows from which the milk is derived are themselves free from disease.

As this commission has no control over the cattle without the limits of the Commonwealth, it naturally follows that, as the law is to-day, it can only purify that portion of the milk supply which is derived from the cows within the limits of the Commonwealth; and there is, therefore, a great deal of justice in the complaint that, while the dairymen of this State are subjected to a rigorous inspection of their cattle, which will in the end insure the production of milk that is free from the germs of tuberculosis, it is also true that large quantities of milk is being sold in this State from cows over which the State has no control, because they are kept outside its limits, and which are as likely to be tuberculous as are the cows of Massachusetts.

If the work of the commission is to continue, as it is now carried on, it may be said that it is not unlikely that the milk brought from without the limits of the State will be even more liable to be contaminated than it is at present; because, under the quarantine orders now established, all neat cattle brought into this State from without its limits, except those that are in transit or for purposes of immediate slaughter, are subjected to a rigorous examination, which results, if they prove to be tuberculous, in their destruction without compensation. As a consequence, only the better class of cattle from the neighboring States are being brought into this State for sale. Assuming that the average condition of the cows in the neighboring States is the same as throughout this Commonwealth, the natural result of this will be that the poorer cattle, including the known consumptives, will be left at home, to become to some extent the natural sources of our foreign milk supply.

A careful consideration of this matter will show that no absolute protection in this direction can be afforded to our people unless the sale of milk and similar products within this State, but derived from animals from without its limits, is regulated in some more efficient manner.

One difficulty of this problem is the question of how far any proper regulation to correct this evil would be an unlawful interference with interstate commerce. The possibilities of successfully enacting such a law is shown by the fact that the supreme court of the United States has recently sustained the law of this Commonwealth regulating the sale within its limits of oleomargarine colored in imitation of butter which has been manufactured without its limits.*

On the other hand, the difficulty of the problem may be appreciated by considering the fact that the same court held that the following statute of Indiana was unconstitutional, as an unlawful interference with interstate commerce. †

> SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That it shall be unlawful to sell, or offer or expose for sale, in any incorporated city within this state, beef, mutton, veal, lamb or pork for human food, except as hereinafter provided, which has not been inspected alive within the county by an inspector or his deputy duly appointed by the authorities of said county in which such beef, mutton, veal or pork is intended for consumption, and found by such inspector to be pure, healthy and merchantable; and for every such offence the accused, after conviction, shall be fined not more than two hundred dollars nor less than ten dollars.

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* Commonwealth *v.* Plumley, December, 1894 † Minnesota *v.* Barber, 136 U. S. 313.

GLANDERS.

While the main work of the commission has been devoted to tuberculosis, considerable work has also been done on the matter of glanders and farcy. Almost the entire time of Commissioner O'Connell has been consumed in going over the State in response to the numerous calls of the local inspectors and others to examine reported cases of glanders and farcy. The method pursued in the case of this disease is the same as heretofore. During the past year the office has received reports of two hundred and thirty animals suspected of being affected with glanders or farcy. All of these have been attended to, and as a result one hundred and sixty animals have been condemned and destroyed. This disease has been found in the past year in the following cities and towns: —

Amesbury,
Arlington,
Ashland,
Bedford,
Belmont,
Boston,
Brookline,
Brockton,
Cambridge,
Canton,
Chelmsford,
Chelsea,
Chicopee,
Concord,
Dudley,
East Bridgewater,
Everett,
Enfield,
Foxborough,
Franklin,
Gardner,
Grafton,
Greenfield,
Harvard,
Haverhill,
Holyoke,
Hopkinton,
Huntington,
Lawrence,
Leominster,
Lexington,
Ludlow,
Lynn,
Malden,
Marlborough,
Melrose,
Methuen,
Millbury,
Needham,
Newton,
Northampton,
Northborough,
North Westport,
Norwood,
Peabody,
Rock Bottom,
Salem,
Somerset,
Somerville,
Stoneham,
Stoughton,
Southbridge,
Springfield,
Stow,
Swampscott,
Taunton,
Tewksbury,
Westborough,
West Boylston,
West Bridgewater,
Westport,
Whitman,
Worcester.

In the report of the commission of last year the attention of the Legislature was called to the fact that there was no adequate provision for inspecting animals suspected of being affected with glanders or farcy, the law of that time as to the inspection of animals applying only to tuberculous cattle; and they recommended that the law be changed so as to direct that the local inspectors of cattle should also examine any horses that for any reason they may at any time suspect of having glanders or farcy. This recommendation was favorably acted upon by the Legislature, and was incorporated in section 4 of the Acts of 1894, which provided that the inspectors "shall also make, from time to time, inspections of all other domestic animals within the limits of their several cities and towns, whenever they have knowledge or reason to suspect that such animals are affected with or have been exposed to any contagious disease;" and the Board feel that the fact that glanders is now reported from a larger number of localities is because the local inspectors have been on the lookout for this disease. The owners of horses killed as being glandered receive no compensation for animals destroyed, the law in this respect being the same this year as heretofore.

The great difficulty in getting rid of glanders lies in the fact that it does not always declare its presence in the animal certainly and surely, and that, even when an animal is known to be affected, he is not reported or otherwise safely disposed of, because he is very frequently able to work satisfactorily, and the owner does not care to become a public benefactor to the extent of the amount invested in the animal. This, however, probably always arises because the danger to the lives and property of others is not fully appreciated by him. There is considerable reason for believing that before much longer, and by the help of an agent called mallein, we shall be able to make as safe and sure a diagnosis in the presence of this disease as we are now able to make in the presence of tuberculosis; and when this time comes, as it probably will in the very near future, this problem will become infinitely less complex, and we shall be able to afford Massachusetts horse owners a practical immunity from a disease which has for years been a very costly one to them.

There have been no outbreaks in this State, so far as the Board has knowledge, of other diseases mentioned in the act, except some small amount of hog cholera, of which twenty-five outbreaks in as many herds have been reported and quarantined. Whenever notice of an outbreak of this kind is received, a letter is written to the inspector of the town in which it has occurred, giving him full directions as to how the herd should be managed. The sick animals are ordered to be carefully separated from the diseased ones, certain other sanitary precautions are advised, and the matter is then left to the management of the local inspector and the owner of the herd in which the outbreaks have occurred. As this is a curable disease, the commission believes that such a procedure as this one is all that is required.

LABORATORY.

Since October, 1892, the Board have constantly felt the need of having a pathological examination made of certain portions of animals that have been sent to them from the different inspectors throughout the State; questions that could not be answered except as a result of laboratory examinations of such portions; and it has been their custom since that time to refer all questions of this sort to Professor Whitney at the pathological laboratory of the Harvard Medical School. As the work has gone on, the number of these examinations that it was found necessary to have made increased considerably, so much so that under former arrangements the entailed expense was becoming considerable. In view of this fact, together with the fact that a great deal of valuable time was lost in sending specimens over to the laboratory and in receiving replies concerning them, it was determined by the Board to establish a laboratory which should be entirely under its own control, and the third floor of the building in which their offices are located was obtained, and has been fitted up for this purpose.

PAYMENT FOR ANIMALS DESTROYED.

One of the most important provisions in the law enacted by the Legislature in 1894 relates to the payment of compensation to the owners of neat stock which are destroyed by order of this Board as affected with tuberculosis. This provision involves a radical change in the policy of the State in these matters, growing out of a better understanding of the hardships which the agricultural citizens of this State might suffer when radical measures for the suppression of this disease were put into operation, in consequence of the enactment of the law of 1894. The portion of the law of 1894 relating to this matter is contained in section 45 of chapter 491 of the Acts of 1894, which is as follows: —

> When the board of cattle commissioners or any of its members, by an examination of a case of contagious disease among domestic animals, becomes satisfied that the public good requires it, such board or commissioner shall cause such animal or animals affected therewith to be securely isolated, at the expense of the owner, or shall cause it or them to be killed without appraisal or payment. Such order of killing shall be in writing and may be directed to the board of health, inspector, or other person, and shall contain such direction as to the examination and disposal of the carcass, and the cleansing and disinfecting of the premises where such animal was condemned, as such board or commission shall deem expedient. A reasonable sum may be paid out of the treasury of the Commonwealth for the expense of such killing and burial. If it shall subsequently appear, upon post-mortem examination or otherwise, that such animal was free from the disease for which it was condemned, a reasonable sum therefor shall be paid to the owner thereof by the Commonwealth: *provided, however*, that whenever any cattle afflicted with the disease of tuberculosis are killed under the provisions of this section, one-half of the value thereof at the time of slaughter for food or milk purposes, and without taking into consideration the existence of such disease, shall be paid to the owner thereof out of the treasury of the Commonwealth, if such animal has been within the state six months continuously prior to its being killed, provided such person shall not have, prior thereto, wilfully concealed the existence of tuberculosis, or by act or wilful neglect contributed to the spread of such disease.

The portion of this section which provides for the payment of tuberculous animals without taking into consideration the existence of the disease was new to the laws of this Commonwealth. As this act came into operation the 20th of last June, this report of the commission also embraces a period from Dec. 15, 1893, to June 20, 1894, when it was operating under a law, being chapter 306 of the Acts of 1893, which provided, in section 2, —

> When any member of the board of cattle commissioners, by an examination of a case of contagious disease among domestic animals, becomes satisfied that the public good requires it, he shall cause such animals to be securely isolated at the expense of the owner, or he shall cause them to be killed without appraisal or payment; but may

pay the owner or any other person an equitable sum for the killing and burial thereof, and may also pay a reasonable sum for the animal destroyed, should it appear by post-mortem examination or otherwise that said animal was free from the disease for which it was condemned.

Under this law of 1893, which specifically included tuberculosis as among contagious diseases, the entire work of the commission in this matter was in response to calls from the local inspectors to examine animals which were reported as quarantined, suspected of being diseased. In this way it condemned as tuberculous 529 animals, for which no compensation was paid to the owner. Since the passage of the act of 1894 the commission has approved the payment for 810 cattle, condemned and destroyed as tuberculous, in the total sum of $15,280.45, making an average payment of $18.86 per head. As this was simply the payment of one-half of the value for milk or beef purposes, which had either been agreed upon or valued by arbitrators, as provided in the act, it means that the total actual value for milk or beef purposes of these animals was $37.72, and that the difference between this value and that paid by the State, on the theory that the animals at the time of slaughter are worth to the owner their value for milk or beef purposes, has been borne by the owner of the animals destroyed.

This section of the law of 1894 is somewhat restricted in the matter of the payment of compensation, and, as this commission has experienced in its application in the field more or less misunderstanding as to its meaning, and under what circumstances the owner receives compensation, it feels that it should make an explanation as to the construction placed upon it by the commission in practice.

It must be remembered, as before stated, that prior to the passage of this act no compensation under any circumstances was paid to the owner for animals destroyed as affected with any of the contagious diseases mentioned in the act.

The act of 1894 leaves the law, in all cases except tuberculosis, unchanged; and therefore, in case of animals destroyed as affected with any of the other diseases mentioned in the act, there is no appraisal, and the owner receives from the Commonwealth no compensation; as, for instance, in the case of a horse destroyed as affected with glanders or farcy, no discretion is vested in the commission, and in no case does the owner of such animal receive any payment for such animal, even though the horse may be one of great value, no matter how long he may have been owned within the State, or how innocent such person may have been in its purchase, or how careful he may have been to guard against its exposure to such contagion.

As to all cases, however, of animals destroyed under the provisions of this act where it is subsequently shown by post-mortem examination or otherwise that the animal condemned was not afflicted with the disease for which it was destroyed, the owner receives the actual value of it from the Commonwealth. While this provision for payment of the actual value of such animal has been the law for two years prior to the passage of the 1894 act, no provision was made in these acts as to how the owner could recover the value of such an animal if the commission or one of its members maintained that the animal was diseased. The commission in its report of last year therefore recommend that some simple provision be made which should give the owner the right to appeal from the decision of this Board, and have the matter of the existence of the disease determined by a disinterested tribunal. An adequate provision for this purpose was therefore made in section 46 of this act, by a petition to the superior court; and thus every person is given a fair opportunity to appeal from this Board to determine in every case whether any animal destroyed by it is actually diseased or not. The commission deem it important that the existence of this provision be kept in mind, because, since the adoption of the tuberculin test by it, which has been discussed in this report, complaints have been brought to the attention of the commission that it is using an unreliable test, and, relying solely upon it, animals which are in fact entirely free from the disease are being killed, and that thus the owner is receiving only half of its value for limited purposes, or even in some cases no value whatever; yet no owner of any animal destroyed has, up to the making of this report, ever brought any action under this provision to review the decision of this Board, and this in itself the commission feel is a strong endorsement of the accuracy of this test.

This provision as to the payment for tuberculous cattle authorizes the payment of "one-half value thereof at the time of slaughter for food and milk purposes, and without taking into consideration the existence of such diseases, if the animal has been within the State six months continuously prior to its being killed."

Again, sections 17 to 22 of the law of 1894, which have been fully discussed previously in this report, provide for the inspection of animals which are slaughtered for food. In the case of these inspections, the existence of the disease is pronounced only upon a post-mortem examination of the carcass after death by the local inspectors. If the carcass is found to be tuberculous, it is immediately destroyed by the inspector without this Board's examining such carcass to pronounce upon the existence of the disease. While this Board does not, therefore, act directly in the matter, it is true, of course, that the matter of these inspections is conducted under the general supervision of the Board, and in such manner as this Board directs. The owner of all such carcasses destroyed receives no payment from the State for them, although the animal may have been within the State six months prior to its being killed, although it may have been born and bred here, and although the owner may have exercised every precaution and taken every step reasonable and proper to ascertain the existence of the disease. Under this section of the act this Board has received the reports of the destruction of two hundred and fifty carcasses as tuberculous. This number is not a fair criterion at all of the number of such carcasses throughout the State, for the reason that the returns of such inspections to the office are very imperfect; but the comparatively small number of such carcasses destroyed leads the commission to feel that the result of the passage of this portion of the act has been satisfactory, and that those persons who previously have been in the habit of slaughtering tuberculous cattle and selling the meat from the same have been obliged to abandon this business.

This act does not permit the payment for cattle destroyed by order of this commission unless the animal has been within the State six months continuously prior to its being killed. Under this provision the commission have required that before the payment for any such animal should be approved the owner should make oath to the fact of such six months' residence. The form of this oath will be found appended as a part of Form for killing tuberculous cattle.

There are many farmers in this State who pasture their cattle during portions of the summer across the line in neighboring States; in which case, although the person may have owned the animal for years, although it may have been bred in this State, no compensation is paid unless the animal has been in the State six months continuously since its return from such pasturage.

The act further provides that the owner shall only receive compensation for such animals if he "shall not have prior thereto wilfully concealed the existence of tuberculosis, or by act or wilful neglect contributed to the spread of such disease."

The Board as yet have not refused the payment for any cattle destroyed as tuberculous where otherwise they came within the provisions in this section; because it is extremely difficult to ascertain whether the owner has wilfully concealed the existence of tuberculosis, or by act or wilful neglect has contributed to the spread of the disease. It is true, of course, that to a certain extent the owner by bringing cattle from different points together into one herd does "by act contribute to the spread of the disease," if in fact any such animals are diseased; but this commission has not felt such a literal construction was the intention of the Legislature, but rather that this provision was intended merely to prevent the owner receiving compensation where he fraudulently or wilfully exposed his animals to contagion for the purpose of obtaining payment from the Commonwealth.

In regard to the amount of the compensation which is paid for animals destroyed as tuberculous, the commission feel that a word of explanation should be given. The act provides that where the animal is in fact tuberculous "one-half of the value thereof at the time of slaughter for food and milk purposes, and without taking into consideration the existence of the disease, shall be paid to the owner thereof," etc. The majority of the cattle destroyed as tuberculous by this commission have no greater value than for food or milk purposes; but, on the other hand, there are many herds of cattle in this State in many of which tuberculosis has actually been found present, and where, therefore, many of the cattle have been destroyed; and there are also many others where the commission have reason to believe a systematic examination by tuberculin, such as contemplated by them, will prove the disease to be present where the animals have a value greatly in excess of that for food or milk purposes. These are fancy-bred, high-grade and registered animals. In case such animals are destroyed by the commission, while they may possibly have a health value of $500 or even $1,000, the owner receives one-half of the value, without taking into consideration any of these special elements.

While this is the basis of valuation in case the animal proves to be diseased, a different basis of valuation is adopted where the animal is found free from disease. The reason for this difference is as follows: If the animal is diseased, the owner only receives such a value therefor as is provided by the statute. It is a value based only upon the milk or beef basis; but where the animal is not diseased, the statute simply provides that "a reasonable sum therefor shall be paid to the owner by the Commonwealth."

The reason for this distinction is that, if the animal is free from disease, it is property taken for the public good, and the owner, under the constitution, is entitled to the value thereof; and in ascertaining that value, as in the case of all other property, all facts tending to give the animal a market value must be taken into consideration, — its pedigree, breed, elements of peculiar value and everything which would have influence upon the mind of a buyer in determining the price which he would pay. Hence, in practice, where the animal is free from disease, the appraisal is entirely disregarded.

Some doubt has arisen in practice as to the exact method of determining the value of tuberculous animals under the provision of the act. The act provides that "one-half the *value thereof at the time of slaughter* for food or milk purposes, and *without taking into consideration the existence of such disease*, shall be paid," etc.

When this section was drawn, it was the intention of the commission, and it was also understood to be the intention of the agricultural committee and the Legislature, that this should simply mean that the basis of value of the animal for payment by the State should be the animal with all her apparent infirmities as she stood at the time of slaughter, simply disregarding the fact that she was then afflicted with the contagious disease of tuberculosis. Appraisers, however, have very largely placed a different construction upon this clause of the statute, claiming that this means that the basis of valuation for such payment is the value of the animal as she would be had she never suffered from the disease. Take, for example, the case of a tuberculous cow which has been subject to the disease for years, whose tissues have been destroyed by it, which has become a bad cougher, has ceased to yield milk to any great amount, is so thin as to be practically valueless for beef purposes, which in fact is in the last stages of the disease, and is what is known as a "frame," — such an animal in the market, for milk or beef purposes, if the disease was not known, would bring possibly five to seven dollars; whereas, if we are to assume as a basis of valuation for payment by the State that not only the actual existence of the disease at the time of slaughter is to be disregarded, but also the effects produced upon the animal itself because of its having been long a subject to it, the animal would be valued at forty or fifty dollars, because, had she never had the disease, she would be a good, fat cow. The commission feel that this latter is not the fair construction to be placed upon this act, or the wise policy to be pursued where compensation is to be paid upon a health basis; and they therefore recommend, if this section is to be construed to mean that the State is to pay for the animal as though it had never been diseased, that it be so amended as to limit it so that the valuation to the State shall not be different from that of the animal in the open market.

We have thus briefly stated the provisions of the law of 1894 under which this Board has acted since June 20, and the practical construction placed upon the act by this Board in its application to the work which it has been conducting since that time.

The matter of the payment by the State to the owners of animals destroyed, on a basis of health, is so new to the law of this State, and, on account of the great increase in the destruction of animals and the different class of animals which are reached through the tuberculin test, is so important, this commission feel that your honorable body should carefully consider the matter of this payment, and determine, in view of this complete change of conditions, the question of what payment should be made to the owners of animals destroyed as best for the interest, not only of such owners, but for all of the citizens of the Commonwealth. This matter has been given considerable attention not only in this State but by other States, and the policy pursued in this direction has varied considerably. There are, briefly speaking, four solutions of this problem which have been adopted or seriously advanced: —

First. — The destruction of all animals found actually infected, without any appraisal and without the payment of any compensation.

Second. — The payment to the owner of the actual value of the animal at the time of slaughter, based upon an appraisal which shall take into consideration the existence of the disease and all other elements of value.

Third. — The payment of one-half apparent or health value of the animal on a limited basis, disregarding the fact that it is affected with tuberculosis.

Fourth. — The payment of the full value of the animal, ascertained in the same manner.

The Board, in order that it may assist as far as possible, your honorable body in arriving at a conclusion as to which of these methods you will adopt, have endeavored to gather together as much material as was practicable bearing on the subject. This may be divided into three classes: —

First. — The history of the law in this State on the matter of compensation of animals destroyed as affected with a contagious disease.

Second. — The arguments which are advanced for and against the several propositions.

Third. — The laws of other States and jurisdictions bearing upon the matter of the suppression of these diseases.

HISTORY OF THE LAW IN THIS STATE.

The law of this State on the matter of compensation directly applying to tuberculosis is extremely recent, for the reason that until 1892 tuberculosis was not treated by the Board of Cattle Commissioners as a contagious disease, and was not specifically included among the list of such contagious diseases under the laws of this Commonwealth. This State, however, has for more than thirty years enacted laws for the purpose of suppressing, from time to time, outbreaks of contagious diseases among the lower animals within its limits.

The first serious attempt to cope with any such diseases was in connection with the suppression of contagious pleuro-pneumonia. This was imported into this State about the year 1857, and spread so rapidly and became such a serious menace to the health of the neat stock that in 1860 this State found it necessary to legislate on the subject. In that year it passed an act (chapter 192) authorizing the governor to appoint three commissioners, who "shall have full power to cause all cattle belonging to a herd in which the disease has appeared or may appear, or which may have belonged to such herds since the disease may be known to have existed therein, to be forthwith killed and buried," etc. Section 2 of this act provided: —

> The commissioners shall cause all cattle in the aforesaid herds *not appearing to be affected by the disease* to be appraised before being killed *at what would have been their fair market value if the disease had not existed*, and the value of the cattle thus appraised shall be allowed and paid out of the treasury of the Commonwealth to the owner or owners thereof.

On account of the fact that contagious pleuro-pneumonia spread so rapidly, and from the knowledge of its dissemination, it was felt that the only safe course to be pursued to stamp it out was not only to destroy the animals which showed upon a physical examination that they were suffering with the disease, but also to destroy all others which were brought into the sphere of contagion; feeling that it was much better for the public welfare that healthy animals might possibly be slaughtered, than that those which had within them the seeds of disease should be allowed to go at large and thus scatter the germs. No reliable agent was known or used to determine with accuracy the existence of this disease in any given animal. Reliance had to be solely placed upon the external symptoms of the disease, determined by physical examination. Under this act, therefore, from the external evidence, the animals destroyed were divided into two classes, — those which were evidently diseased, and those which were apparently sound but possibly might have the disease within them. In regard to these two classes the State adopted a different policy as to the payment of compensation.

In the case of animals which could be demonstrated as affected, no compensation was paid. In such animals, however, the disease had so advanced and its development was so rapid that in the natural course of events the animal would soon die from the effects of the disease itself.

In the case of the animals which were destroyed because of their possible exposure to infection, the State paid the full health value. The reason for this distinction as to the payment was not that in one case the public good required it and the other not, or that in one case it was a hardship upon the owner and in the other case not, but was upon the basis that in the case of the animal diseased it was a public nuisance and menace to the public health and to a vast amount of money invested in the neat stock throughout the State, and was so affected with the disease as to become actually worthless. In the other class of animals, however, it was impossible to demonstrate the existence of the disease, and it could not be proved that in any particular case the animal was actually infected, and therefore that that particular animal was a public nuisance. The destruction of such an animal was fairly within the clause of the constitution which provides that " whenever the public exigencies require, that the property of any individual should be appropriated to public uses, he shall receive a reasonable compensation therefor."

This law in the case of contagious pleuro-pneumonia gave greater powers to the commission than those vested by the present law in this Board, for that authorized the destruction of animals simply because of their exposure to a disease, whereas in the case of the present law this Board must determine in each case the existence of the disease ; and yet the Legislature considered that when the State was threatened with so great an evil as that, the adoption of so rigorous a policy was the only practical means of stamping out the disease. The result has justified their expectations. By the adoption of these measures this dreaded disease was absolutely stamped out in this State, and for twenty-seven years not a case has been known within the limits of the Commonwealth.

Different measures were adopted in other States, where it was attempted to eradicate the disease by the destruction only of such animals as plainly showed that they were affected with the disease by a physical examination. This method only resulted in its wider spread, and it finally took years of persistent effort, the expenditure of vast sums of money, and finally the adoption of Massachusetts methods, before the disease was stamped out. As a result, not a case of this disease exists on this continent.

About two months after the passage of this contagious pleuro-pneumonia act, the same Legislature, on June 12, 1860 (chapter 221), authorized an increase of the Board of Commissioners from three to five, and gave them power over "pleuro-pneumonia or any other contagious disease now existing among the cattle of the Commonwealth." The law was not otherwise substantially varied, and the rule as to compensation was left unchanged, except that it was provided that "the appraised value of such cattle shall be paid, one-fifth by the cities or towns in which said cattle were kept, and the remainder by the Commonwealth."

After the passage of this act the law remained substantially unchanged until 1878. Contagious pleuro-pneumonia had long before this been stamped out in the Commonwealth. Tuberculosis at this time had not been considered by scientists as a contagious disease, and therefore was not so considered or treated either by the law or this commission. Prior to this the powers of the commission were limited to diseases *in cattle*. As a practical question, therefore, there were no diseases in the State calling for their active intervention or over which they had control for years before the matter of glanders was taken up.

In 1878 (chapter 24) an act was passed providing that: —

> The selectmen of towns, the mayor and aldermen of cities and the cattle commissioners of this Commonwealth shall have and may exercise the powers and shall be subject to the duties for the prevention of the diseases known as farcy and glanders among horses, asses and mules, and for the prevention of contagious and infectious diseases among domestic animals that are now conferred or imposed upon them by the laws relating to the prevention of contagious diseases among cattle.

Otherwise the law was left the same as previously. No special provision was made in this act as to the matter of compensation. As cases of glanders were to be destroyed under the same circumstances as pleuro-pneumonia, the act called for the destruction of animals actually diseased without the payment of compensation, and apparently authorized the destruction of animals which had been exposed to the disease, and where the disease could not be proved to exist; but in such case full health value would have to be paid, as in the case of pleuro-pneumonia.

In the following year, 1879, the matter of compensation for glandered horses was given special attention, and an act was passed (chapter 160) which provided: —

> Section 1. In all cases of glanders or farcy, the appraisal of the animal so diseased *shall be based on its value in its diseased condition*, and the appraisers shall be the following persons: first, one member of the board of commissioners on contagious diseases among cattle; second, one veterinary surgeon selected by said commissioner; third, one reputable person who may be selected by the owner of the animal if he choose to do so, otherwise the two appraisers above-named shall select the third.

This was the first act in this Commonwealth distinctly providing that diseased animals should be appraised, and that the value of such appraisal should be the actual value on the assumption of its having the disease. The commission operated under this act for two years. Experience showed that a glandered horse, if the existence of the disease was taken into consideration, had absolutely no value, and that therefore the machinery of an appraisal yielded the owner no benefit, and merely caused delay and unnecessary expense to the State.

Accordingly, in 1881 (chapter 184) this act was repealed, and in its place was substituted: —

> Section 1. In all cases of glanders or farcy, the commissioners on contagious diseases among cattle, having condemned the animal infected therewith, *shall cause the same to be killed without appraisal*, but may compensate the owner thereof in such equitable sum as shall pay for the killing and burial of the same.

The entire matter of contagious diseases was again considered by the State at the time of the passage of the Public Statutes, and the law on the matter was codified into chapter 90. This act gave the mayor and aldermen of cities and the selectmen of towns the right, —

> . . . in case of the existence in this Commonwealth of the disease called pleuro-pneumonia among cattle, or farcy or glanders among

horses, or any other contagious or infectious diseases among domestic animals, —

to quarantine the suspected animals, to cause them to be examined by a veterinary surgeon or physician, and if adjudged to be infected, to cause them to be killed. Section 3 of the act provided that such boards —

> . . . may cause all such animals to be appraised by three competent and disinterested men under oath, *at the value thereof at the time of the appraisement*, —

and such value was to be paid one-fifth by the city or town and four-fifths by the Commonwealth.

While, therefore, the law of 1882 theoretically authorized the payment of the diseased value, as has already been stated, practically, if the disease was taken into consideration, such value did not exist.

In 1885 (chapter 148) the law on the matter of compensation was again amended by providing in section 3 that, when the mayor and aldermen in cities or the selectmen in towns destroy an animal that is affected with contagious disease, —

> . . . they may cause *all such animals except those infected with glanders or farcy to be appraised* by three competent and disinterested men, under oath, *at the value thereof at the time of appraisement*, and the amount of the appraisement shall be paid as provided in section one. *They shall cause all animals infected with glanders or farcy to be killed without appraisement*, but may pay the owner an equitable sum for his services in the killing and for any reasonable expense incurred by the burial thereof.

As a result of this act, therefore, appraisal in the case of glanders and farcy was done away with; in the case of all other diseases the actual value, if any, at the time of slaughter, was paid. As, however, the main efforts at that time were directed to the stamping out of glanders and farcy under the law as practically operated, no compensation was paid.

In the same year (chapter 378) an act was passed creating the present Board of Cattle Commissioners, except that it has since been enlarged by the act of 1894 from three members to five. The Board then created until 1887 worked under the laws contained in the Public Statutes, as amended by the act already cited.

In 1887 the entire matter of contagious diseases was again given attention by the Legislature, and resulted in the passage of an act (chapter 252) repealing the previous laws. This act of 1887, with some slight amendments, was the law under which this commission worked until the passage of the act of last year. The sections of this act relating to compensation are 12 and 13: —

> SECT. 12. The commissioners, when in their judgment the circumstances of the case and the public good require it, may cause to be killed and buried any domestic animals which are infected with or have been exposed to contagious disease, and *except as provided in the following section shall cause such animals to be appraised* by three competent, disinterested men, under oath, *at the fair value thereof in their condition at the time of appraisement*, and the amount of the appraisement and necessary expense of the same shall be paid as provided in section one [*i. e.*, one-fifth by the city or town and four-fifths by the Commonwealth].
>
> SECT. 13. When the commissioners, by an examination of a case of contagious disease among domestic animals, *become satisfied that it has been contracted by intention or negligence* on the part of the owner or the person in his employ or by his consent, or by the use of food materials liable to contain the germs of contagion, they shall cause such animals to be securely isolated at the expense of the owner, or *they shall cause them to be killed without appraisal or payment, and in all cases of farcy or glanders the commissioners having condemned the animal infected therewith shall cause such animal to be killed without an appraisal, but may pay* the owner or any other person an equitable sum for the killing and burial thereof.

Under this law, as before in the case of glanders and farcy, the appraisal was dispensed with and no value was paid. In all other cases, provided the disease was not due to his wilful or negligent act, the owner received the actual value of the animal, taking into consideration the disease. But here again it must be remembered that substantially the only disease then being considered was glanders and farcy.

This law remained unchanged until 1892. In this year for the first time tuberculosis was treated as a contagious disease. Under all the laws prior to this, although in theory tuberculosis was included because it was a contagious disease, as a matter of fact it was not so treated by this Board. We have already stated that tuberculosis in cattle is identical with consumption in a human being. The true nature of this disease and its communicability was not discovered until 1882, when Koch first found it to be a germ disease. No government attempted to include it among contagious diseases in animals until France so placed it in 1887.

In 1892 this Board came to the conclusion that it was a menace to the public health, and that steps should be taken to prevent its further spread; and accordingly it recommended to the Legislature of that year the passage of an act which should provide some systematic method of locating the animals which were affected by the disease; and accordingly an act was passed entitled "An act to prevent the spread of tuberculosis" (chapter 195), which provided for the appointment of inspectors throughout the State, giving them power to —

> . . . inspect all animals kept for the production of milk, and shall report to the board of cattle commissioners all suspected cases of tuberculosis which come to their notice, among animals intended for slaughter or kept for the production of milk.

This act further amended section 13 of the act of 1887 by providing that, —

> *In all cases of tuberculosis, farcy or glanders*, the commissioner having condemned the animal infected therewith, *shall cause such animal to be killed without an appraisal*, but may pay the owner or any other person an equitable sum for the killing and burial thereof; and may also pay a reasonable sum for the animal destroyed, should a post-mortem examination prove that said animal was free from the disease for which it was condemned.

The law which was in force at the time this act was passed authorized the destruction of diseased animals without appraisal or payment; it was but natural, therefore, that, as soon as it was realized that tuberculosis was a contagious disease, which should be eradicated if possible, the same policy should be adopted as in the case of glanders, especially because at this time the methods pursued in determining the disease were identical with those of glanders; that is, in both cases reliance was solely placed upon a physical examination. The animals condemned by the commission were those reported by the local inspectors as affected with the disease, and therefore consisted only of animals where the disease had so far advanced as to give external evidence satisfying persons of ordinary skill that they were affected with the disease. When the disease had so far advanced as to give these external symptoms, it had in a great majority of cases so destroyed the tissues of the body and so robbed the animal of its vitality, that, looked at from every stand-point, not only because of its danger to the public health but as a mere money-making machine, it was practically valueless. It was but natural, therefore, that the law should dispense with the unnecessary machinery of appraisal, and that such animals should be classed in the same category with glandered or farcied horses.

For the first time in the laws on this matter this act provided that, where it should subsequently appear that the animal was free from disease, the owner should receive the full value. This change in the law was the result of a decision of the supreme court in this State in a case where this Board ordered a horse killed in Rehoboth as affected with glanders under the provision of the law, without appraisal or payment. The owner claimed that his animal was free from the disease, and sued the constable who acted under the authority of this Board for the value of the animal, claiming that he had no right under such an order to destroy an animal which was actually sound. The court in this case carefully reviewed the law, and stated that this section which authorized the destruction of glandered horses without compensation "by implication declares horses with the glanders to be nuisances, and we assume in favor of the defendant that it may do so constitutionally, and may authorize them to be killed without compensation to the owners;" but the statute does not declare all horses to be nuisances, and, as a result, the court decided that, while the Legislature might properly cause animals actually diseased to be destroyed, it could not deprive a man of a healthy animal for the public good without paying the value; that, as to the destruction of such animals, it came within the provision of the constitution, and that, as it was taken for the public good, the owner must receive the value. (Miller *v.* Horton, 152 Mass. 540.)

In 1893 (chapter 306) both of the previous compensation sections were consolidated into one which provided, —

SECT. 2. When any member of the board of cattle commissioners, by an examination of a case of contagious disease among domestic animals, becomes satisfied that the public good requires it, he shall cause such animals to be securely isolated at the expense of the owner, or he shall *cause them to be killed without appraisal or payment*, but may pay the owner or any other person an equitable sum for the killing and burial thereof, and may also pay a reasonable sum for the animal destroyed, should it appear by a post-mortem examination or otherwise that said animal was free from the disease for which it was condemned.

This act also, for the first time, defined the contagious diseases: —

SECT. 3. Contagious diseases within the meaning of this act shall include glanders, farcy, contagious pleuro-pneumonia, tuberculosis, Texas fever, foot and mouth disease, rinderpest, hog cholera and rabies.

This law placed all diseases on the same footing, did away with the appraisal in every case, and required that in no case should an owner receive any compensation.

From this brief examination of the history of the law prior to the passage of the act of last year, it is apparent that the general tendency of the law had been uniformly in the direction of the payment of no compensation. This Board did not adopt the tuberculin test until long after the passage of the law under which it is now operating. When, therefore, this commission made its report to the Legislature in 1894, its experience was entirely based upon physical examinations, condemning only such animals as clearly demonstrated that they were affected with tuberculosis, and which generally had ceased to have any apparent earning capacity; and when, therefore, it advised a thorough revision of the law relating to contagious diseases among domestic animals, it did not feel that it could recommend a change in the law on the matter of compensation, until, at least, it had ascertained by experience the practical effect of the law which it recommended.

In the bill submitted by it, therefore, the matter of compensation was left as before, except that it recommended the making of some adequate provision whereby the owner should have by a simple method the power, if he so desired, to appeal from the decision of this Board to some disinterested tribunal, which might determine whether or not in each particular case the animal condemned was in fact affected with the disease.

In addition to the bill submitted by this Board three other bills were submitted, bearing on the matter of the compensation to be paid to the owner. One of these bills provided: —

> SECT. 11. A reasonable sum may be paid out of the treasury of the Commonwealth for the expense of such killing and burial and *one-half of the actual value of the animal for food or milk purposes, if in health*. . . . If the cattle commissioners or their agents or owners of such animal or animals cannot agree on the fair cash value, it shall be determined by appraisal of three disinterested persons to be mutually agreed upon; *but no payment shall be made on any animal not owned within the state six months prior to its being killed, or to any person who has wilfully concealed the existence of tuberculosis, or who, by act or wilful neglect, has contributed to the spread of the disease.*

The second act provided in section 2 that it shall be the duty of the commission, —

> . . . also to cause a disinterested appraisal of the animal or animals affected with the said disease in accordance with such rules and regulations by them as hereinafter authorized and provided, and also to cause the said animals to be destroyed, and *to pay the owner or owners thereof one-half of their value, as determined upon the basis of health before infection*, out of any moneys in the treasury not otherwise appropriated: *provided, however, that no appraised value shall be more than one hundred dollars for any animal killed; and provided, further*, that in no case shall compensation be allowed for an animal destroyed under the provisions of this act which may have contracted or been exposed to such diseases in a foreign country or on the high seas, *or that may have been brought into this state within one year previous to such animal showing evidence of such disease;* nor shall compensation be allowed to any owner who in person or by agent knowingly or wilfully conceals the existence of such disease or the fact of exposure thereto in animals of which the person making such concealment by himself or agent is in whole or in part owner.

The third bill provided, in the case of all animals diseased, that —

> If it appears that the animal killed by order of the board was diseased, a sum may be allowed by said board to the owner not exceeding half the amount which would have been allowed if said animal had been free from disease.

There was, therefore, before the Legislature of last year no bill or petition requesting the payment of full health value. This Board, however, in its report of that year, recommended that, —

> If indemnity is to be paid at all, it should be full. Half measures produce generally half results; and if it were possible to limit the expenditure in this direction to within proper bounds, it might safely be considered that the benefit to the community would offset its cost to them.

After a careful consideration of our report and these several bills, the committee on agriculture reported the law which subsequently became chapter 491 of the Acts of 1894.

ARGUMENTS FOR AND AGAINST COMPENSATION.

First. — The destruction of all animals found actually infected, without any appraisal and without the payment of any compensation.

Those in favor of this position assert that the policy of this State for the past thirty years until the passage of the act of last year is in favor of this proposition. They further say that such a course is constitutional, because, by the destruction of diseased animals without compensation, the State is not depriving any person of his property without compensation; that such a diseased animal has no actual value; that, because the beef and milk products from such an animal are a great source of danger to human beings, the owner should not be allowed to keep it; that the Legislature may properly declare that such an animal is a public nuisance, and require it to be destroyed without compensation; and in support of this they cite the decision of the supreme court in the case of the glandered horse before referred to,* where the court stated that it assumes that the Legislature may constitutionally declare such horses to be public nuisances, and "may authorize them to be killed without compensation to the owner," and claim that, as this course has been held constitutional, it is unwise to depart from it. They further say that in matters of public health the policy of the State generally has been for the owners to bear all the burdens; citing the laws requiring that persons infected with contagious diseases may be quarantined and required to pay the entire expense, that lunatics may be confined at their own expense or that of their relatives, that owners of property may be required to bear the expense of disinfection, that owners of orchards attacked by the gypsy moth may have them destroyed without payment, or that owners of houses may have them pulled down under the same circumstances, to prevent the spread of fire. They claim that, in the case of diseased animals, the reason in favor of the destruction of such animals without compensation is, that there is no cure or preventive which can be successfully used when once the animal is affected; that not only will such disease ultimately destroy the animal, but that such animal will be the centre of infection, and spread the disease among others not only of their kind but among human beings; and that therefore the loss which the owner suffers is not due directly to their destruction by the State, but to the fact that the animal has contracted the disease, and that such destruction by the State is merely the removal of a worthless thing. They further assert that, while the public gain a benefit by the destruction of such animals, the direct benefit in the first instance, at least, is to the owner of such stock; because if such diseased animals are allowed to remain they will eventually contaminate the whole herd, with the result, therefore, that the owner loses not only the one or two affected animals, but possibly all the animals in his barn; and that when the State undertakes, without expense to such owner, a careful and thorough examination of his stock, and by that examination to remove all sources of contagion and thus enable the owner to save the lives of all the balance, it is bearing its just proportion of the expenses; and, finally, they assert that, as these diseased animals are in fact worthless, the payment of anything to the owner for such animal is not a compensation for property destroyed, but is a gift by the State in exchange for something which is worthless, and will encourage the surreptitious introduction into this State of diseased animals from other localities;

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* Miller *v.* Horton, 152 Mass. 540.

and that thus eventually the State will afford a market where the owners of such worthless stock may receive a very large profit, and, because of this fraudulent introduction, the State can never eradicate the disease.

Those who oppose the destruction of tuberculous animals without compensation principally favor the payment to the owner of a sum of money based upon a health value; and their reasons for advancing this will be stated under these headings. In addition, however, they assert that, while many of the animals which are destroyed as tuberculous are in fact worthless, a large number of them, especially of those which are detected by the tuberculin test, have to the owner a real value, because they have, under existing laws and in practice, an earning capacity at least equal to that of healthy stock; that if the State did not destroy them, under proper sanitary conditions and where the disease was in its incipient stage, they might possibly recover; and in support of this they cite the hospital statistics of post-mortem examinations showing that a certain percentage of human beings who die have within them lesions of consumption which are entirely healed; that certainly these cows would under favorable conditions live for many years, during which they would produce a substantial income to their owners not only from the sale of milk, which in many cases is unusually copious, but also from their calves, which are born free from tuberculosis (it having been demonstrated that it is not an hereditary disease), and which therefore might grow up under healthful conditions, fed upon milk where the germ is not present, and become perfectly healthy cattle in every respect.

In answer to this, however, those who favor no compensation assert that, while in theory such calves may possibly grow up to be healthy, in practice they are the first to become diseased, because they inherit a weakened constitution and thus fall an easy prey to the disease to which they are constantly exposed through its presence in their parents.

Second. — The payment to the owner of the actual value of the animal at the time of slaughter, based upon appraisal which shall take into consideration the existence of the disease and all other elements of value.

Those who favor this proposition assert that by the adoption of this rule justice would be done not only to the owners of the cattle destroyed but to the public at large. They assert that these animals which are destroyed by the State are in fact the property of the owner, and have a substantial value, for the reasons already given; that by the destruction of such animals the State is depriving the owner of his property, and in consequence he should be reimbursed as others are whose property is taken for the public good, by receiving from the State the exact value thereof; that the policy of the State has always been to provide, in every act which deprives a man of his property, that he should receive the value, and that he should have an easy means whereby that value could be determined by a disinterested tribunal; that if this were done the owner would receive from the State whatever the animal was really worth, taking into consideration its capacity to yield milk, the fact that the offspring of such animal are free from the disease and may therefore grow up to be healthy animals, and all other elements which go to make up the value of such property; and they further assert that this is the policy which has been adopted by a large number of other States where the same work is being performed, citing the laws of Rhode Island, Connecticut, Pennsylvania, Illinois, Ohio, Iowa, Missouri, Indiana and Kansas.

Those who oppose this proposition assert that, as a matter of fact, in the appraisal of such animals upon their *actual value* the fact must be taken into consideration that the animal is affected with a contagious disease; and that whenever competent persons are called upon to value such an animal, taking into consideration the fact of such contagion, it will always result in arriving at a value which is substantially nothing, because such value, after all, must be what purchasers would pay for such animal in the open market under all the circumstances, knowing the fact that the animal has this contagion and is liable to spread it among other stock with which it is brought in contact, and that the product of such animal is dangerous to the public health; and they assert that in fact no purchaser could be found who would be willing to pay anything for such animal; and they cite in this connection the experience of the State under the laws which authorized the payment of the actual value of glandered horses, which resulted in an abandonment of the law and a final adoption of a provision which provided for no compensation, because in experience the appraisal was found to give no value to the owner, and simply put the State to unnecessary expense and trouble.

Those who favor this proposition say, in answer, that the experience of the State in the case of glanders was in connection with an entirely different disease, which quickly proves fatal; that the animals destroyed had no value because they yield no food product; that, in so far as it applies to the experience in the past in the case of tuberculosis, that experience was based entirely upon the destruction of animals in the advanced stage of the disease, based upon a physical examination; and that, when animals are to be destroyed relying upon the tuberculin test, a different class of animals is reached, many of which are to all external appearances sound.

Third. — *The payment of one-half apparent or health value of the animal on a limited basis, disregarding the fact that it is affected with tuberculosis.*

Fourth. — *The payment of the full value of the animal, ascertained in the same manner.*

Both of these propositions are supported and opposed in substance by the same class of persons and upon the same arguments, based upon the expediency or non-expediency of paying to the owners a portion or all of what they may have more or less innocently invested in the stock destroyed.

Those who favor this payment on either basis assert that, as a question of expediency, such payment should be made, and that otherwise the law works a great hardship upon the farming and agricultural community without their receiving any commensurate benefit. They assert that, while it may not have been a serious hardship to this class to have their animals destroyed as tuberculous, relying only upon a physical examination, with the introduction of tuberculin as a means of determining the existence of this disease the conditions entirely change.

For the first time, in tuberculin there has been placed in the hands of the State a reliable agent for the detection of this disease. They cite the fact that by the use of this agent very many animals throughout the State are being condemned and destroyed as tuberculous which have every external appearance of being sound and healthy, which have been yielding large quantities of milk, which are still apparently in full health and vigor, and which would, if allowed to live, yield to the owners for many years a material return; that, while such animals may have within them the seeds of this disease which may ultimately sap their vitality, they exhibit no external symptoms of it; and that, were it not for the intervention of the State and the demonstration of the existence of the disease by the tuberculin test, not only could the farmer receive a full return from the animal, but such an animal in the market, judged by all means which are within the power of the ordinary buyer, would frequently sell as freely and for as high a price as other animals in which the disease does not exist; and that therefore the State is merely paying to the owner what he could obtain in the open market for his animal had not the State stepped in and pointed out its latent defects; that this tuberculin test is a purely scientific method, which can be safely and successfully used only by those who have peculiar skill, a scientific training and a more or less extended experience in its use; that therefore it is entirely without the reach of farmers and dairymen as a means of assisting them in determining whether the stock they have purchased is sound and free from the disease. Not only is it without their power to use it, but, because of its recent introduction and because the reliability of it has only been comparatively recently demonstrated, it has not been within the control of veterinarians; and they assert, therefore, that the agricultural class has not had the power, either themselves or by the calling in of others, to gain the benefit of the knowledge derived from its use; that these owners of stock have used every reasonable precaution that ordinary business men would bring to bear to ascertain that their stock is as healthy and free from disease as circumstances will permit; that this disease is not only not of recent introduction, but has been existing and spreading among neat stock for years without any steps having been taken by the State to stamp it out, and therefore that it is in no sense their fault that this marvellous agent should suddenly find that their cattle are affected with this insidious disease; that not only have the agricultural class bought from time to time these cattle in good faith, as sound, but that in fact they have invested large sums of money in this stock, and that to-day it is their main source of livelihood; that, while the value of a single cow may be small, the aggregate capital invested by this class in such cattle is large; that there are to-day in this State 223,536 head of neat stock, which, upon the average value for milk or beef purposes, as found by appraisal of animals destroyed by the commission, of $37.72 a head, means a total investment in such cattle of $7,657,405; that, inasmuch as the commission, as based upon its work in the field during the past six months, has found that there are probably ten per cent. of the stock throughout the State tuberculous, this means a destruction of perhaps $765,740 worth of such cattle on a health basis; and that, if the agricultural class are obliged to bear this entire loss, it means not only a ruin of their business in the State, but a consequent loss to the public, because it will drive the dairymen from the State, and thus cut off the local source of milk supply upon which the citizens depend, and which can, while such cattle are within the State, be so regulated through the systematic examination of all cattle within the limits that the public will be assured of a healthful supply of milk; whereas, if this business be driven from the State, this milk must come from cattle kept without the limits, where the Commonwealth cannot regulate the healthiness of the stock from which it is derived, and therefore the State will fail to accomplish one of the principal objects hoped to be obtained by this work, — *i. e.*, a supply of milk free from this source of contagion.

They assert that the policy of paying for the animals found by the tuberculin tests to be affected does not substantially vary in practice from that which was adopted in the case of pleuropneumonia; that in the case of that disease, animals which showed upon physical examination that they were diseased were destroyed without payment, while animals which did not so externally exhibit the disease were only destroyed upon payment to the owner of the full health value; that when tuberculin is used, many animals reached and destroyed are those which, if a physical examination were relied upon, would not be detected, and would only be destroyed upon the theory that the contagion cannot be eradicated except by the destruction of all of the animals in the herd which have been exposed to it; and that, as in such case the owner would receive the full health value, he should not be deprived of that value because the existence of such disease is demonstrated by this agent which the dairyman has not himself the skill to apply. And, finally, they assert that the policy of seeking out these disseminators of contagion by the use of tuberculin, and destroying them, is a broad public-health policy adopted by the State for the purpose of protecting, as far as possible, the lives and property of its subjects; that the real reason which leads to the destruction of these animals is because the food products derived from them are a source of danger to its citizens; that this danger extends to all those who consume these products, and that therefore it is a measure in which all are equally interested, and the benefit of which will be reaped by everybody, without distinction as to class or calling; that, inasmuch as this is a public measure, in which the public generally are vitally interested and where the benefit is shared equally by all, the same policy dictates that it is equitable and just that the entire expense or loss derived therefrom, whether it be due to the cost of the administration of the law, to its enforcement, or to the loss which the owners of the animals suffer by reason of this destruction for the public good, should be borne equally by all; and that the only method of doing this is by having the State pay full indemnity and bear the entire expense, which thus will be equitably distributed through the medium of taxation of all its citizens.

They further assert that, by the adoption of a policy of paying to owners a fair value for their animals, the State encourages such persons to bring forward all diseased animals, and that thus a great assistance will be afforded to the commission in its work by the hearty co-operation of the agricultural class, who thus will feel every encouragement to assist in the stamping out of this disease; whereas, under a system which provides for destruction without indemnity, unscrupulous men will use every endeavor to dispose of as yet incipient or occult cases of tuberculosis, and thereby plant the infection widely in new herds, and that as a result the State will never be able to thoroughly eradicate the disease.

Those who oppose the payment of any remuneration on the health basis assert that it is a payment to the farmer by way of a gift of a sum of money, which is not the value of the animal destroyed, but is in the nature of an insurance against the existence of the disease; and that in fact it makes the State an insurance company, as far as farmers are concerned, in connection with tuberculosis, in the same sense that any live stock company takes risks upon animals which they underwrite, without, however, the farmers having to pay any premium, and without the State's having the opportunity to first examine the animal, to determine whether it is sound, before assuming the risk.

They claim that the payment to a favored class of persons of a sum of money by the State for animals destroyed, not based upon their actual value, and only when the owner has conformed to certain regulations of the State, is unconstitutional, because it is in no sense a reasonable compensation paid to an individual for property appropriated for public uses within the meaning of the constitution; and because, as the money which is paid is raised by taxation, it is not a payment necessary for "the protection and preservation" of the citizens of the Commonwealth, or otherwise, within the purpose for which State government has power to raise money by taxation.

They assert that it is not true that animals which are tuberculous in any degree have a real value to the owner, which can be regarded by the Commonwealth; that such alleged value depends upon the right of the owner to sell the milk or meat derived from such an animal; that by being allowed to retain such an animal he reaps the benefit only so long as he is allowed to sell its diseased products; that, if the State should examine all the neat cattle within its limits, and, instead of destroying those diseased, plainly brand them as such, and then should pass sanitary laws, which would be but just, that the meat and milk from such tuberculous animals should not be sold in the open market, from that moment the animal would cease to have any earning value, and if after that the State should go through and destroy such animals upon any equitable system of appraisal, the owner would receive no value for the same; and therefore he should not, under existing laws, receive a payment from the State because he is prevented by means of the destruction of his tuberculous stock from selling diseased meat and milk; that the public reaps the benefit from the destruction of such animals in the same manner that it does from laws which prevent the sale of adulterated food and other similar products, or from those which in any way restrain the doing of a wrongful or criminal act; that, while apparently the loss by the destruction falls on the agricultural class, the loss is not due to the destruction, but due to the existence of the disease; that, while it may be a serious loss to the agricultural class to lose their animals through tuberculosis, it is simply a loss which is incident to the trade which they have seen fit to carry on; and that, if they have had the misfortune to invest in materials of their business which either are at the time of such purchase, although unknown to them, or which subsequently become in their possession, worthless, from causes over which the consumer of their products has no control, the policy of the State no more dictates that it should bear this loss than that it should bear the loss which others suffer by reason of business reverses.

They assert that a policy involving the payment to the farmers of a portion of or the whole of the value of such animals, upon a basis other than their actual worth, considering the disease, is an encouragement to these owners to be careless about the sanitary conditions under which their cattle are kept; and that this would result in the unnecessary exposure of the stock to the ravages of the disease, and so reduce their power of resistance as to make them an easy prey to it. And they cite in this connection numerous statistics tending to show that the percentage of this disease among the human race increases directly in proportion to the density of the population of the locality where they dwell, and that where the sanitary conditions of such people are the poorest, there the percentage of consumption is the greatest. They further assert that, inasmuch as the majority of the cattle in this State are kept for dairy purposes, any law which pays to such persons the full health value of their tuberculous stock will eventually cause the majority of these animals to be purchased by the State; because, they say, by keeping his cattle in close, heated quarters, where they have an insufficient supply of pure air, where they are fed upon rich food materials and where they are bred oftener than once a year, the owner receives the greatest annual return, but that this treatment results in so wearing out the constitution of the animals that they die at an early age and are rendered highly susceptible to tuberculosis; and if in the end the farmer can receive from the State the full health value of such animals, the law would defeat itself, because it would be much more profitable to do this than to keep his animals under normal conditions, where, while they may last longer, the owner can receive nothing for such animals on their death.

They further assert that such payment will result in the importation of diseased animals into the State for the purpose of selling them to the government, stating — what is undoubtedly true — that such animals may be bought for a few dollars, and that if they can sell them to the State at $37.72 a head, or even $18.86 a head, they would obtain such a large profit that it would encourage this illicit trade, which it would be practically impossible to prevent.

In answer to this last argument, those who favor the proposition assert that if, coupled with the law providing compensation, a minimum limit is imposed of residenceship of such animals before the owner can receive compensation, the danger of the loss of the total value of the animals if found and destroyed within that limit of time would so discourage the introduction of such animals that but few would be imported; that, by means of proper quarantine regulations such as have already been established, all such animals can be stopped and examined at the State line, and if found tuberculous will be destroyed; and that, by a system of branding animals within the State which have been found free from the disease, the introduction of such animals into the State without the brand would immediately expose the practice, and that thus as a result there would be but little danger from this source.

As between the half indemnity and the full indemnity, those who favor the half indemnity assert that under the circumstances it is a more just and equitable distribution of the burden and benefit; that, while the farmer reaps the benefit with other citizens resulting from the State's obtaining a pure food supply, he reaps an additional benefit by having the State remove from his herds, without expense to him, this source of contagion, which is liable ultimately to destroy them; and that therefore he should bear a greater share of the expense than he would by simply paying his proportion of the taxes; and, further, that by paying one-half indemnity there would not be sufficient inducement to unscrupulous persons to practise fraud upon the State for the purpose of obtaining this amount.

Those who favor the full indemnity assert that half measures do but little good; that, by a system of one-half indemnity, unscrupulous persons are encouraged to so over-value their animals as that they will in effect receive the full indemnity, while the honest and conscientious dairyman would be placed at a disadvantage; that the theory of paying compensation is based upon the assumption that the owner has invested his money in good faith in the stock destroyed; that as the State does not make him whole by paying one-half only, and, as the loss from this means may be large to him, it encourages him to secrete his animals, to prevent their being tested and possibly destroyed, and to otherwise thwart or hamper the State in its work of stamping out the disease; whereas, by the payment of full compensation, the owner suffers no loss, he is merely given the opportunity of replacing his unsound animals with sound ones; that therefore it will be for his benefit to assist the State in every way in stamping out the disease, that thus every agriculturist throughout the State will be on the lookout to detect and report the disease; and, as a result of all this, while the State will pay out a greater or less sum by way of indemnity to the owners for the animals destroyed, it will render the performance of the work very much easier, and thus to a greater or less extent so far reduce the administrative expense that in the end the cost to the State will be but little if any more than would result from the attempt to perform the work without remuneration to the owner, and at the same time will not discourage a business in which so many of its citizens are so largely interested.

As a part of the proposition of paying indemnity on the health value, those who favor it also approve the adoption of some restriction as to the residence, as was done in the case of the act passed in the State last year, which requires that the animal must have been owned in the State six months prior to its having been killed. Against the adoption of this six-months rule it is argued that it works a hardship in many cases; and that there is no greater reason why a farmer who buys stock in good faith, believing it to be sound, and pays the full price for the same, after having exercised every precaution, should receive nothing from it when subsequently found to be infected, because it has not actually been within the State six months; while his neighbor, who has raised his stock upon his own farm, and has possibly thereby perpetuated the disease through interbreeding and exposure to the contagion, should receive from the State the full value for the same. It is further claimed that this rule works an injustice upon farmers living on the border line, who pasture their cattle in the neighboring States during the summer.

As against this, however, it is claimed that, while these persons would lose the value of such animals if destroyed within six months after they have returned from such pasturage, inasmuch as this State is endeavoring to stamp out the disease from cattle within its limits, and thereby to place in the power of the agricultural class the means of keeping their cattle healthy, if anyone of such persons sees fit to remove his cattle from the State and expose them to possible contagion under circumstances over which the State has no control, he should take the risk of the loss which has resulted from his own acts; they further assert that, by the adoption of proper quarantine regulations and examination, as now established by this Board, such cattle would upon their return be properly tested and destroyed at the border before entering the State, and thus the farmer would lose such cattle even without a limit of residenceship.

In the matter of payment of compensation on a health basis, the State of Nebraska is paying full health value.

The following States are paying for tuberculous animals a limited health value: Massachusetts, Maine, New Hampshire, Vermont, New York and New Jersey.

In the following States a limit of ownership within the State is required: Three months, Rhode Island, New York, New Hampshire; six months, Massachusetts, Vermont, Nebraska; three years, Maine.

As bearing on this matter of the payment of compensation, the Vermont Agricultural Experiment Station, in its Bulletin No. 42, of July, 1894, on Bovine Tuberculosis, sums up the matter as follows: —

> The arguments for and against the indemnity system may be summed up briefly as follows: —
>
> 1. The indemnity system encourages the disclosure of the existence of disease and favors its more complete eradication, while the

absence of some such system leads to the concealment and dispersion of disease. In many cases the comparatively small expenditure for indemnity distributed among many tax payers is truer economy than the losses in life and money caused by animal diseases which have been concealed.

2. The indemnity system recognizes the rights of property.

3. Since the public is benefited in being guarded against disease, it should bear its share of the cost of that protection.

On the other hand: —

1. The indemnity system is apt to encourage disease. The stock owner is less careful if he can rely on the State to purchase his infected animals, even though at a low rate.

2. Diseased animals are often collected at a low figure from other owners and other States for the purpose of getting indemnity from the State.

3. It is liable to become a burden to the tax payer.

4. The State essentially insures breeders and owners against their mistakes and misfortunes. While it is hard to lose property in any form, a diseased animal is a nuisance. There should be no question between a loss of dollars and the not improbable ruin of the health of human beings.

From the stand-point of disease eradication only, there is no question that a liberal indemnity promptly paid is preferable to any other course.

Prof. James Law, of the New York Tuberculous Commission, in Bulletin 65, April, 1894, of the Cornell University, Agricultural Experiment Station, Veterinary Division, gives the following views: —

Insufficient Indemnity a False Economy.

In conclusion, it is right to emphasize the importance of a due consideration of property rights. Sanitary laws which in any way ignore or disregard the rights of property have within themselves the seeds of defeat. If within our municipal abattoir the butcher cannot conduct his business as well and economically as in his own establishment, he or his competitors will evade the law in some way. If the stock owner is not fairly reimbursed for his animals slaughtered and for other losses sustained for the protection of the public health and of the country's herds, unscrupulous men will find ample means of trading off the as yet incipient and occult cases of tuberculosis, and thereby planting the infection widely in new herds. *Compensation must stop short of making the sanitary bureau a profitable customer for tuberculous animals at sound prices, but it must be so liberal as to enlist the ready co-operation of the stock owner in having every infected beast safely disposed of.* Cases of advanced generalized tuberculosis may in all justice be listed at a low rate, as they are in every sense unfit to live, and are an expense, a danger and a nuisance even when dead. Cases, too, that have just been imported from another State or country, and which are either manifestly diseased or taken from a tuberculous herd, may fairly be excluded from indemnity, and above all from a liberal indemnity. *But in nearly every herd the majority of the stock condemned are to all outward appearances sound animals, and the owner has had no suspicion concerning them until this has been betrayed by the tuberculin test.* But for that he would have gone on utilizing the animals in perfect good faith, and his customers would have received the dairy products in all confidence as to their wholesomeness. Had he wished to sell these animals for the dairy or for beef, he would have found plenty of purchasers at sound market rates. If the stock were thoroughbred and their progeny of a high prospective value, he could have continued to breed from them for years, — since calves are rarely born tuberculous, not once in many thousand births, even from tuberculous parents; and thus he might have largely profited by raising them on the milk of healthy cows. Then, again, in country districts the owner must bear the cost of disposing of the carcass by burning or burial in some place to which other animals do not have access. Further, the essential work of disinfecting the premises is at present put on the shoulders of the stock owner. Once more, if the stock owner is a dairyman, his trade is injured by the condemnation of animals in his herd. *Customers will suddenly change to other dairies, creameries will be closed against his milk, and health officers are likely to quarantine the product, at least between the condemnation and slaughter.* Apart from this, his home supply of milk is lessened, and to keep his customers he must go into the market and buy milk from others.

It is quite evident that in many cases of dairy herds and of valuable thoroughbred animals an indemnity amounting to even the sound market value of the animals killed comes far short of reimbursing the owner for his actual losses.

These considerations should be taken fully into account, before adopting any proposal to fix a maximum sum or rigid rule for estimating values.

RECOMMENDATIONS.

The Board have thus endeavored to give, thoroughly and impartially, the history of legislation in the matter of compensation for diseased animals in this State; they have also collected and presented many of the arguments, both for and against such payment, which have been advanced; and they have presented herewith portions of the laws of many of the other States bearing upon the matter.

In conclusion, the Board desire to state, as a result of their study of the matter, that they are impressed with the practical weight of many of the arguments that are advanced in favor of paying a full value, on a limited basis, for all animals destroyed for the public good. In arriving at this conclusion they have been very largely governed by the fact that, by using tuberculin as a means of diagnosis, they are now condemning and finding diseased animals that, to all external appearances, are perfectly healthy and sound, and that have a full earning capacity for their owners.

Without desiring to discuss further the policy involved in the adoption of such measures, they feel that if your honorable body can constitutionally and safely enact a law authorizing a payment for animals condemned as tuberculous, which will fairly enable their owners to replace them with healthy stock, it will practically result in a benefit to the community at large, which will be commensurate, at least, with its cost. As a result of their experience in this work during the last two and one-half years, the Board are thoroughly satisfied that tuberculosis is widely scattered among the neat stock throughout the Commonwealth; and that it will be impossible to stamp it out, unless some vigorous policy is adopted, which shall also provide for a thorough and systematic examination upon a scientific basis of every head of neat stock within its limits.

The efficient performance of this work will necessarily involve the expenditure of a considerable sum of money; but the benefit which will be derived therefrom will, in the opinion of the Board, be greater; and they feel that the State can well afford, in accomplishing this end, not only to pay the administrative expenses, but, if it is necessary in order to stamp out this disease, to also pay whatever may be required to fairly indemnify the owners of the animals which are destroyed as a result of this policy. They believe, further, that if the farmers and dairymen lose the cost of these animals, or any considerable portion of it, it will be a serious blow to the agricultural interests of the State. They feel that if the valuation of the animals can be properly limited, so that the owner shall not receive any greater sum from the State than he would receive if the animals were sold in the open market, as they stand, with all their faults, but under the assumption that both buyer and seller are ignorant of the existence of tuberculosis, as disclosed by the tuberculin test, there could be but little encouragement to practise fraud upon the Commonwealth. It is further believed that if such a policy as this is instituted it will encourage the hearty co-operation of owners in the work; and, as a result, the administration will be easier, more efficient, and will possibly cause but little increase in the ultimate expense over that of the present method. If coupled with this a limited time of ownership is required, and a proper quarantine maintained against all animals coming into the State, there will be but little danger of the introduction of diseased animals from without its limits for the purpose of obtaining the compensation paid by the State.

If full indemnity upon this plan is adopted by the Commonwealth, the burden will be divided fairly between the community at large and the farmers, who not only pay their share of the tax, but in addition have to take upon themselves the cost of maintaining the animals during the necessary quarantine, and who also suffer to a considerable degree from the attending interruption to their business.

FREDERICK H. OSGOOD, *Chairman*,
CHARLES P. LYMAN, *Secretary*,
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,
Board of Cattle Commissioners.

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TWELFTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1894.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1895.

Commonwealth of Massachusetts.

Boston, Jan. 10, 1895.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Twelfth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,
Secretary.

MASSACHUSETTS STATE
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

BOARD OF CONTROL, 1894.

HIS EXCELLENCY FREDERIC T. GREENHALGE,
Governor of the Commonwealth, President ex officio.

W. H. BOWKER of Boston, ... Term expires, 1895.
C. L. HARTSHORN of Worcester, ... Term expires, 1897.
Appointed by the State Board of Agriculture.

J. H. DEMOND of Northampton, ... Term expires, 1896.
E. D. HOWE of Marlborough, ... Term expires, 1896.
Appointed by the Board of Trustees of the Massachusetts Agricultural College.

F. H. APPLETON of Peabody, ... Term expires, 1897.
Appointed by the Massachusetts Society for Promoting Agriculture.

W. H. PORTER of Agawam, ... Term expires, 1895.
Appointed by the Massachusetts State Grange.

WM. C. STRONG of Newton Highlands, . . Term expires, 1897.
Appointed by the Massachusetts Horticultural Society.

H. H. GOODELL, A.M., LL.D., Amherst,
President of the Massachusetts Agricultural College.

C. A. GOESSMANN, Ph.D., LL.D., Amherst,
Director of the Station.

WM. R. SESSIONS, Hampden,
Secretary of the State Board of Agriculture.

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Vice President.

WM. R. SESSIONS, Hampden,
Secretary and Auditor.

C. A. GOESSMANN, Amherst,
Treasurer.

STATION STAFF.

C. A. Goessmann, Ph.D., LL.D., *Director and Chemist*, . . Amherst.
J. B. Lindsey, Ph.D., *Associate Chemist* (*Feeding Department*), . Amherst.

Assistants.

C. S. Crocker, B.S., .	*General and Analytical Chemistry.*
H. D. Haskins, B.S., .	" " "
C. H. Jones, B.S., .	" " "
F. L. Arnold, B.S., .	" " "
C. H. Johnson, B.S., .	" " "
E. B. Holland, B.S., .	*Assistant Chemist in Feeding Experiments.*
R. H. Smith, B.S., .	" " " "
L. E. Goessmann,* . .	*Assistant Chemist and Clerk.*
David Wentzell, . .	*Farmer.*

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* Resigned July 1, 1894.

TWELFTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

Gentlemen: — The different lines of investigation decided upon in preceding years have been pursued during the past year. No material changes have been introduced in regard to the general character of the work assigned. The different plans for the experiments presented from time to time at the quarterly meetings for your endorsement have been carried out as far as practicable to the full extent of the means at hand. The results obtained in this connection compare well with those of preceding years. The advanced stage of some of the experiments imparts to the results obtained for obvious reasons from year to year an increased interest, and may claim for our reports a due consideration on the part of our farming community as well as students of agricultural progress in general.

The feeding experiments with different kinds of farm live stock, inaugurated soon after the establishment of the Experiment Station, have received ever since most careful attention. The inquiries into the economy of substituting several reputed forage crops, new to our section of the country, for meadow hay in the daily diet of milch cows, have been continued during the past year with much success. Several new kinds of waste products of corn (maize) and other grains have been tested with reference to their degree of fitness to serve as ingredients in efficient grain rations for different kinds of farm live stock. Much work has been accomplished in connection with the use of the Babcock apparatus for the determination of fat in milk and cream.

The question of using skim milk supplemented in various ways for the production of veal has been studied in a series of experiments with calves.

The digestion experiments with sheep, for the purpose of ascertaining the rate of digestibility of the various food constituents of some new coarse and fine feed stuffs peculiar to our markets, have been materially increased in number. The detailed record of these and other observations of interest in this connection, which have been under the special supervision of Dr. J. B. Lindsey, associate chemist of the Experiment Station, furnishes the first part of the accompanying annual report, under the following headings: —

PART I.

FEEDING EXPERIMENTS.

I. A practical talk about feeding.
II. Objects of the different experiments.
III. Feeding experiments with milch cows (two).
IV. Hay substitutes.
V. The Babcock *v.* the space system, etc.
VI. Feeding experiment with steers.
VII. Feeding calves for veal.
VIII. Digestion experiments.
  1. Digestion experiments with sheep.
  2. The digestibility of the pentosans.

The experiments in the field and in the vegetation house have been quite numerous and of a varying character. Some of them are a continuation of those of former years, while others are new. Much attention has been devoted to the raising of nutritious forage crops fit for green fodder, hay and ensilage; the results are gratifying, and cannot fail to exert a desirable influence on the future supply of coarse fodder for farm live stock, as far as quantity as well as cost of production and valuable composition is concerned. The good success noticed in the field during the first part of the summer season was in some instances seriously checked by a severe drought during the month of August. A description of the different experiments carried on in this connection by the writer forms the second part of the succeeding annual report, under the following-named headings: —

PART II.

FIELD EXPERIMENTS.

1. Field experiments for the purpose of studying the economy of raising leguminous plants (clover, etc.) as a means of enriching the soil in nitrogen in the interest of the subsequent raising of grain crops (Field A).
2. Field experiments with several prominent varieties of potatoes and some prominent mixed forage crops (Field B).
3. Field experiments to ascertain the influence of different mixtures of commercial fertilizers on the yield and general character of several prominent garden crops (Field C).
4. Experiments with forage crops (27), to study their fitness for our climate (Field D).
5. Trial of an early maturing variety of Minnesota dent corn (Field E).
6. Field experiments with different commercial phosphates, to study the economy of using the cheaper natural phosphates or the more costly acidulated phosphates (Field F).
7. Experiments with forage crops (vetch and oats and Hungarian grass, Field G).
8. Field experiments to study the effect of phosphatic slag and nitrate of soda as compared with ground bone on the yield of oats and corn (east field).
9. Experiments with permanent grass lands (meadows).
10. Orchard. Experiments with home-made stable manure, unleached wood ashes and several mixtures of fertilizing materials on the growth and yield of several varieties of fruit trees.
11. Observations in the vegetation house.
12. Report on general farm work.

The work in the chemical laboratory of the station is steadily increasing. The progress of the work in the field, the barn and the vegetation house in some cases calls for much analytical chemical work, and the applications of the citizens of the State for free analyses of fodders, fertilizers, well water and a variety of waste products are from year to year more numerous. The amount and character of the work in the chemical laboratory may be judged from the following statement, which represents the third part of the report: —

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Communication on commercial fertilizers: —

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895 (58).
4. Analyses of licensed fertilizers (253).
5. Analyses of commercial fertilizers and manurial substances sent on for examination (145).
6. Miscellaneous analyses (4).
7. Miscellaneous fodder analyses (69).

The chemical analyses made in connection with investigations carried on at the station are reported in the description of the work.

II. Analyses of milk sent on for examination (40).
III. Analyses of water sent on for examination (200).
IV. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse substances used for fertilizing purposes.
V. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.
VI. Table of digestibility of American feed stuffs.

The weather observations for local purposes have been continued, and copies of our records have been regularly sent to the United States department, according to directions. The periodically published bulletins have been as many as in previous years. The number of regular applicants for copies is increasing. The supply of copies of previous years is in many cases exhausted.

The condition of the buildings pointed out in my preceding report has not been changed; some of the farm buildings need repairing of roofs and repainting. The laboratory buildings (brick) are in a fair condition; their outfit has not been materially increased, for economical reasons.

In concluding, it gives me particular pleasure to acknowledge the satisfactory assistance I have enjoyed from all parties associated with me in carrying out the work assigned. Thanking you for the kind consideration received in the past, I am,

Yours very respectfully,

C. A. GOESSMANN,
Director.

AMHERST, MASS., Jan. 1, 1895.

ANNUAL REPORT OF C. A. GOESSMANN,

Treasurer of the Massachusetts State Agricultural Experiment Station,

For the Year ending Dec. 20, 1894.

Received.

Cash on hand from last year,	$252 65	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from fertilizer account,	3,090 00	
Cash from dairy bureau,	11 00	
Cash from farm,	1,153 42	
Cash from miscellaneous sources,	79 95	
		$14,587 02

Expended.

Cash paid salaries,	$4,287 18	
Cash paid laboratory supplies,	660 79	
Cash paid printing and office expenses,	887 63	
Cash paid farmer and farm labor,	2,379 84	
Cash paid farm supplies,	1,764 24	
Cash paid fertilizer account,	3,090 00	
Cash paid construction and repairs,	544 50	
Cash paid expense of Board of Control,	90 54	
Cash paid incidental expenses,	382 92	
Cash paid library,	277 84	
Cash on hand,	221 54	
		$14,587 02

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION (DEC. 20, 1894).

Live stock,	$645 00	
Tools, implements and machinery,	843 90	
Produce on hand,	364 00	
Fertilizers,	196 00	
Laboratory inventory,	3,500 00	
Office furniture, library, etc.,	2,095 00	
Furniture, herbariums, library and collections,	1,300 00	
Photographic supplies,	150 00	
Greenhouse apparatus,	200 00	
Mycologists' apparatus,	350 00	
Chemical apparatus and supplies,	300 00	
Buildings, land, etc.,	30,570 00	
		$40,513 90

This is to certify that I have examined the books and accounts of Charles A. Goessmann, treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 20, 1894, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of two hundred and twenty-one fifty-four one-hundredths dollars, which is shown to be in the bank.

WM. R. SESSIONS,
Auditor.

JAN. 15, 1895.

PART I.

FEEDING EXPERIMENTS

AND

DAIRY STUDIES.

BY J. B. LINDSEY.

I. A Practical Talk about Feeding.
II. Objects of the Different Experiments.
III. Feeding Experiments with Milch Cows (two).
IV. Hay Substitutes.
V. The Babcock *v.* the Space System, etc.
VI. Feeding Experiment with Steers.
VII. Feeding Calves for Veal.
VIII. Digestion Experiments.
    1. Digestion Experiments with Sheep.
    2. The Digestibility of the Pentosans.

I.

1. A BRIEF PRACTICAL TALK ABOUT SOME OF THE PRINCIPLES INVOLVED IN FEEDING OUR FARM ANIMALS.

In order to feed the live stock of the farm to the best advantage, it is important that the farmer be familiar with the elementary principles of animal nutrition.

Now the body of the animal is made up, generally speaking, of four distinct groups of substances, namely, (1) water, (2) flesh (lean meat), (3) fat, (4) ash.

The percentage of water in different animals in different stages of growth varies in round numbers from 40 to 85 per cent.; the percentage of bone framework of the body from 6 to 12 per cent.; the flesh, not including blood and entrails, composes from 30 to 48 per cent.; while the fat varies from 5 to 40 per cent.

An average composition of the various farm animals would be somewhat as follows: bones, 8.9 per cent.; flesh and teeth, 40.1 per cent.; fat that can be removed by mechanical means, 23.9 per cent.; and blood, hair, horns, entrails, including foods contained therein, 27.1 per cent.

The milk, an animal product, contains approximately 87 per cent. of water, 3.5 per cent. of casein and albumen or nitrogenous matter, of which the lean meat of the animal is also a type, 0.7 per cent. of ash and about 8.5 per cent. of fat and milk sugar.

The flesh or lean meat is composed of nitrogen, carbon, hydrogen, oxygen, sulphur and phosphorous; its characteristic element is the nitrogen. Small quantities of ash also enter into its composition. The bones are made up partly of nitrogenous matter, such as glue, gelatine, etc., partly of fat and partly of ash. The ash or earthy part of the bone, as some call it, is composed principally of phosphate of lime. The fat contains no nitrogen, but has as high as 76 per cent. of carbon, the balance consisting of oxygen and hydrogen.

The ash constituents of the body consists essentially of lime, potash, soda, magnesia, iron, phosphoric acid and sulphuric acid. The phosphate of lime predominates.

Now, these various substances, making up the animal body, — flesh, fat, ash and water, — are formed or obtained direct with the aid of the oxygen of the air from the substances termed foods that the animal consumes. Our neat stock, for example, consume the various coarse fodders and grains and have the power within them of converting these vegetable foods into flesh, fat and bone.

Recognizing, then, the composition of the animal body, both as regards its groups of substances and the more elementary substances that make up these groups, let us turn our attention to a brief study of the foods from which the body is built up.

Classification and Composition of Cattle Foods.

(*a*) *Classification.*

For our purpose cattle foods may divide into: (1) coarse fodders, (*a*) those rich in carbohydrates (cellular matter, starch, etc.) and low in protein, and about 50 to 65 per cent. digestible, (*b*) the legumes when cut in bloom, rich in protein and about as digestible as (*a*); (2) root crops, also rich in carbohydrates and low in protein, but very digestible; (3) concentrated foods with a digestibility of from 75 to 85 per cent. The concentrated foods should be subdivided into (*a*) those rich in carbohydrates and comparatively low in protein, such as wheat, rye, barley, oats and corn; and (*b*) those that are rich in protein and comparatively low in carbohydrates, as peas, beans, gluten feeds and meals, cotton-seed meal, linseed meals, peanut meal, etc.

Table of Classification.

COARSE FOODS.		ROOTS.	CONCENTRATED FOODS.	
(*a*) Low in protein, high in carbohydrates; 50-65 per cent. digestible.	(*b*) High in protein, medium in carbohydrates; 50-65 per cent. digestible.	Low in protein, rich in carbohydrates; very digestible.	(*a*) Low in protein, high in carbohydrates; 75-85 per cent. digestible.	(*b*) Very high in protein, low in carbohydrates; 75-85 per cent. digestible.
Hays of various grasses, straws, corn fodder, corn straw, corn ensilage.	Clovers, peas, beans, soya bean, vetches, serradella, etc.	Mangolds, sugar beets, turnips, potatoes, carrots, etc.	Wheat, rye, barley, oats, corn.	Pea and bean meal, gluten feeds and meals, cottonseed meal, linseed meals, peanut meals, etc.

(*b*) *Composition.*

All of our cattle foods have been divided into five groups of substances: (1) crude ash, (2) crude cellulose, (3) crude fat, (4) crude protein, (5) extract matter. Water is always present, and might be called a sixth group.

Each one of the first five groups can be resolved into more simple substances. With some of the substances or compounds making up the groups we have only a partial knowledge.

(*1*) *Crude Ash.*

By crude ash is meant the mineral ingredients of the plant or seed remaining behind after the organic portion has been destroyed by fire. The ash or ashes of a plant consist essentially of lime, potash, soda, magnesia, iron, phosphoric acid, sulphuric acid, etc.

Functions of the Ash. — It is these various mineral ingredients that serve to build up the bony structure of the animal; they also enter into and are necessary components of the flesh itself.

(*2*) *Crude Cellulose.*

The crude cellulose is the coarse or woody part of the plant; we may term it the framework of the plant. Its elementary composition is carbon, oxygen, hydrogen and a small percentage of ash. The crude cellulose is largely present in straws and hays; the various grains, on the other hand, contain but a small percentage. Cows, oxen, sheep and horses have a digestive tract so arranged as to be able to consume and digest large quantities of such coarse fodders.

Functions of the Cellulose. — It cannot form flesh, but serves to produce vital energy and fat.

(3) *Crude Fat.*

By crude fat is meant not only the fats and oils found in the various foods, but also the waxes, resins, etc. It has also been termed "ether extract," because it is that portion of the plant soluble in ether. Its elementary composition is carbon, oxygen and hydrogen, with a much higher percentage of carbon than either the cellulose or extract matter.

Functions of the Fat. — It serves the same purposes as the cellulose; it furnishes, however, two and one-half times as much heat or energy as the cellulose.

(4) *Crude Protein.*

Protein is a general name for all the nitrogen-containing bodies found in our common agricultural plants. It might be called "vegetable meat." It corresponds, generally speaking, to the lean meat of the animal body. All protein or albuminoids contain on an average about 16.5 per cent. of nitrogen. It is, other things being equal, the most valuable food constituent of the plant. Its elementary composition is carbon, nitrogen, oxygen, hydrogen, phosphorus and sulphur.

Functions of the Protein. — The protein is a source of energy, and is *the only source of flesh.* It also has been considered a source of fat, although much doubt has lately been thrown upon this idea.

(5) *Extract Matter.*

The so-called non-nitrogenous extract matter consists of the starch, sugars and gums. A large part of the extract matter of the coarse fodders (one-third to one-half) consists of the wood gums or pentosans. It has been shown that in the majority of cases the pentosans are as valuable for food as other carbohydrates. The elementary composition of the extract matter is carbon, oxygen and hydrogen.

Functions of the Extract Matter. — The sugars, starch and gums furnish energy, and serve as sources of fat. The crude cellulose and the extract matter, having the same functions in the animal economy, namely, the production of energy and fat, have been termed carbohydrates. The ash, while a necessary ingredient of all complete foods for live stock, is not generally considered in compounding suitable daily diets for our farm animals; so that, for practical purposes, we really have to do with but three groups: (1) protein, (2) carbohydrates, (3) fat.

Having noted the different groups of substances of which our agricultural plants are composed, let us briefly turn our attention to the value of these groups as sources of nourishment. No one of them is of itself a suitable food for our farm animals, nor will any one of them sustain life for any length of time.

Digestibility of Cattle Foods.

Foods are valuable as sources of nourishment only in so far as their various constituents or groups can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder. In order to combine the various fodders into what has been termed a fodder ration, it is important to know how large a part or per cent. of the various groups is digestible. A great many digestion experiments have been made with various cattle foods, especially in Germany; during the last six or seven years a considerable number have been carried out in the United States. A tabulated list of all American experiments will be found at the end of this report.

How the Digestible Matter of a Food is determined.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams)
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.09
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

Having noted the various groups of substances going to make up our cattle foods, and recognizing that these groups are valuable as sources of nourishment only in so far as they are digestible, let us next inquire into the *proper way of combining these foods*, so as to produce properly balanced daily diets or

FODDER RATIONS FOR THE ANIMALS OF THE FARM.

A great many experiments have been made in order to study the behavior of the protein, carbohydrates and fat in the animal body, and their specific influences upon the formation of flesh, fat and milk. We will not attempt in this connection to give in detail the results of these studies, but simply state that they have led to the combining of our coarse and concentrated foods in such a way as to obtain in the daily diet of the animal the digestible protein, fat and carbohydrates in certain reasonably definite proportions.

The German investigator Wolff, who has made a close study of all experiments along this line, has concluded that a milch cow, for example, in order to produce a large and well-sustained yield of milk, should be fed about 2.5 pounds of digestible protein, .5 pound of digestible fat and 13 pounds of digestible carbohydrates daily, on the basis of 1,000 pounds live weight. In preparing fodder rations for milch cows, then, it should be our aim to so combine the coarse and concentrated foods as to obtain these groups in the approximately correct proportions. Variety and palatability of food must also be taken into consideration.

How Fodder Rations are made up.

In order to show how fodder rations are put together, we will construct one from English hay, corn meal, cotton-seed meal and wheat bran. We must know (1) the analyses of the fodders and (2) their digestibility. These data are to be found in the table following: —

Table showing Composition and Digestibility.

	English Hay.		Corn Meal.		Cotton-seed Meal.		Wheat Bran.	
	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.
Moisture,	15.00	-	14.00	-	7.00	-	10.00	-
Dry matter,	85.00	-	86.00	-	93.00	-	90.00	-
	100.00	-	100.00	-	100.00	-	100.00	-
Dry matter contains: —								
Crude ash,	6.20	notdet.	1.62	notdet.	7.30	notdet.	7.50	notdet.
" cellulose,	31.00	60	2.15	77	7.70	-	11.00	25
" fat,	2.80	49	3.83	85	12.00	97	5.00	72
" protein,	10.00	60	11.00	72	44.00	88	18.00	78
Extract matter,	50.00	60	81.40	94	29.00	64	58.50	68
	100.00	-	100 00	-	100.00	-	100.00	-

The average composition and the average per cent. digestible of all cattle foods are to be found in tables at the end of this report.

Rules for compounding Properly Balanced Fodder Rations.

1. A milch cow of 1,000 pounds live weight needs approximately 2.5 pounds of digestible protein, .5 to .75 pound of digestible fat and 13 pounds of digestible carbohydrates daily.

2. Calculate the rations on the basis of 1,000 pounds live weight. Cows weighing but 700 to 800 pounds will need only seven-tenths or eight-tenths as much. (This is not always true. Example: very thin cows fresh in milk would need rather more, and cows in fair to good condition towards the end of lactation less.)

3. Use 21 pounds of English hay or its equivalent of some other coarse fodder as a basis. (This will furnish 1 pound of digestible protein, and it is now necessary to make up the necessary amount of protein by the addition of concentrated fodders. In doing this the necessary carbohydrates not furnished by the hay will also be added.)

4. Use 8 to 10 pounds of two or three different grains, about one-third of each kind. (Not over 3 pounds of corn meal should be added. The various gluten feeds can often take the place of corn meal to advantage. It is almost always economical to use 3 pounds of bran. As the third grain 2 to 3 pounds of one very high in protein should be used, such as cotton-seed meal, or one of the gluten or linseed meals.)

5. Reduce the quantity of each of the substances to be fed *to dry matter*, by multiplying by the *average per cent. of dry matter* in such substances, as found in the tables.

6. Multiply the amount of dry matter in each of the foods by the average percentages of cellulose, fat, protein and extract matter it contains, and these products by the *digestion percentages* of these same groups. The last products will be the amount of digestible cellulose, fat, protein and extract matter contained in each of the several foods. Add the several digestible amounts as found in the various foods together, and the sum will be the total digestible cellulose, fat, protein and extract matter in all of the feeds going to make up the daily ration.

7. To calculate the nutritive ratio of the ration, multiply the amount of digestible fat by $2\frac{1}{2}$, and add the product to the digestible cellulose and extract matter; divide this sum by the digestible protein, and the dividend will be the ratio required.

A Practical Example.

Fodder Ration for a Milch Cow of 1,000 Pounds Live Weight.

	Digestible.			
	Protein.	Fat.	Carbohydrates.	Total.
	Pounds.	Pounds.	Pounds.	Pounds.
Needed,	2.50	0.50	13.00	16.00

Ration shall be composed of: —

21 pounds English hay.	3 pounds cotton-seed meal.
3 pounds corn meal.	3 pounds wheat bran.

	Fodders.			Fodder Constituents.			
	Pounds as Fed.	Per Cent. Dry Matter therein.	Pounds Dry Matter.	Per Cent	Pounds.	Per Cent. Digestible.	Pounds Digestible.
				(a) Cellulose.			
Hay,	21×	85=	17.85×	31.00=	5.53×	60=	3.31
Corn meal,	3×	86=	2.60×	2.15=	0.06×	77=	0.05
Cotton-seed meal,	3×	93=	2.80×	7.70=	0.22×	00=	0.00
Wheat bran,	3×	90=	2.70×	11.00=	0.30×	25=	0.07
Total,							3.43
				(b) Fat.			
Hay,	21×	85=	17.85×	2.80=	0.50×	49=	0.25
Corn meal,	3×	86=	2.60×	3.83=	0.10×	89=	0.09
Cotton-seed meal,	3×	93=	2.80×	12.00=	0.34×	88=	0.30
Wheat bran,	3×	90=	2.70×	5.00=	0.13×	72=	0.09
Total,							0.73
				(c) Protein.			
Hay,	21×	85=	17.85×	10.00=	1.78×	60=	1.07
Corn meal,	3×	86=	2.60×	11.00=	0.29×	72=	0.21
Cotton-seed meal,	3×	93=	2.80×	44.00=	1.23×	85=	1.04
Wheat bran,	3×	90=	2.70×	18.00=	0.49×	78=	0.38
Total,							2.70
				(d) Extract Matter.			
Hay,	21×	85=	17.85×	50.00=	8.92×	60=	5.35
Corn meal,	3×	86=	2.60×	81.40=	2.11×	94=	1.98
Cotton-seed meal,	3×	93=	2.80×	29.00=	0.81×	95=	0.77
Wheat bran,	3×	90=	2.70×	58.50=	1.58×	68=	1.07
Total,							9.17

Summary.

	Pounds.
Total digestible protein,	2.70
Total digestible fat,	0.73
Total digestible cellulose and extract (carbohydrates),	12.60
Total digestible organic nutrients,	16.03

These figures correspond very closely with the amounts required (see top of page 22).

Calculating the Nutritive Ratio.

	Pounds.
Carbohydrates,	12.60
Fat, .73 pound × 2½ =	1.82
Total,	14.42

14.42 pounds carbohydrates ÷ 2.7 pounds protein = 5 34, or as 1 protein is to 5.34 carbohydrates (1 : 5.34).

The Real Meaning of Nutritive Ratio.

Nutritive ratio is simply the numerical relation which the fat and carbohydrates bear to the protein which is taken as unity; or, stated in the form of a problem, how many more units of carbohydrates and fat reduced to carbohydrates are present in the ration than units of protein?

It has been demonstrated by experiment that, other things being equal, the best returns can be secured in case of milch cows, for example, if the various fodders are so combined as to produce a ration containing 4.5 to 5.5 times as much carbohydrates as protein; or, in other words, rations having a nutritive ratio of 1 : 4.5 to 5.5.

While this proportion should be kept in mind in making up the fodder ration, palatability and variety should by no means be lost sight of.

Rations with a nutritive ratio of 1 : 4.5 to 6 are termed narrow rations; those with ratios of 1 : 6 to 1 : 10, wide rations.

2. SOME GOOD FODDER RATIONS FOR FARM ANIMALS.

I. Milch Cows and Growing Neat Stock.

These animals should have 16 pounds of digestible organic nutrients daily divided into: digestible protein, 2.50 to 3.00 pounds; digestible fat, .50 to 1.00 pounds; digestible carbohydrates, 12 to 13 pounds; on the basis of 1,000 pounds live weight. These various ingredients will be found in the correct proportions in the following combinations: —

I. Basal Rations.

(*a*)	(*b*)	(*c*)
English hay,[*] 18 pounds. Roots, . . 15 pounds.	English hay, 21 pounds.	English hay, . 4 pounds. Corn stover, . 4 pounds. Corn ensilage, 40 pounds.

(*d*)	(*e*)	(*f*)
Hay, . . 5 pounds. Dry corn fodder, 25 pounds.	Hay of vetch and oats, 10 pounds. English hay, 5 pounds. Corn stover, 6 pounds.	Green crops,[†] 50–70 pounds.

These coarse fodders for practical purposes can generally be fed *ad libitum; i. e.*, the animals can be given all they will consume. There are, of course, some exceptions, but the practised eye of the feeder will control such cases.

II. Grain Rations.

The following grain rations are combined to go with the above coarse fodders. These should always be weighed or measured out: —

---

[*] The many experiments at this station have shown that hay is too costly to be fed in large quantities to cows and growing stock. Its place should be taken by other coarse fodders.

[†] In case green leguminous crops are fed, only one-half to one-third of the grain ration that follows need be given.

(*a*)

Cotton-seed meal,	100 pounds.
Wheat bran,	100 "
Corn meal,*	100 "

Mix and feed 9 quarts daily.

(*b*)

Chicago gluten meal,	100 pounds.
Wheat bran,	100 "
Gluten feed,*	100 "

Mix and feed 9 quarts daily.

(*c*)

Linseed meal,†	100 pounds.
Wheat bran,	100 "
Ground wheat,	100 "

Mix and feed 9 quarts daily.

(*d*)

Linseed meal,†	100 pounds.
Pope or King gluten meal,	100 "
Wheat bran,	200 "

Mix and feed 9 quarts daily.

The maize or gluten feeds can be used interchangeably one for the other; the linseed meal and Chicago gluten meal can also be substituted one for the other. Cotton-seed meal, King gluten meal and Pope gluten meal should not be combined (especially in summer) with other concentrated foods rich in fat, and it is better to feed but one of these in any daily grain ration. To be on the safe side, we would not advocate more than 2 or at the utmost 3 quarts of these feeds daily.

In making up the grain rations, cost must be considered, and farmers will have to use judgment in this respect. Thus, if cotton-seed meal costs $24 per ton and Chicago gluten meal $26, the cotton-seed meal would be much more economical.

The following figures show the approximate *relative commercial values* of the grains, figured on the basis of the amount of digestible protein they contain. By this is meant that if corn meal was worth $21 per ton Chicago gluten meal would be worth $28, etc. This does *not* mean that these two grains, side by side, would have the same feeding effect, but the figures are presented as a basis to be used in purchasing: —

	Per Ton.
Corn meal,	$21 00
Wheat brans,	18 00
Gluten feeds,	23 00
Gluten meals,	28 00
Cotton-seed meal,	30 50
New-process linseed meal,	29 00
Old-process linseed meal,	28 25

---

* Three quarts of either Buffalo gluten feed, Peoria gluten feed or Chicago maize feed can be substituted with good effect for the corn meal.

† Old or new process.

II. WINTER FODDER RATIONS FOR GROWING LAMBS (60 TO 100 POUNDS).

The following combinations of grains and coarse fodder have proved valuable as winter fodder rations for lambs (yearlings).

In general, where corn ensilage has been substituted for one-half to two-thirds of the rowen the growth has been fully as good and the cost of production of live weight somewhat less.

I.		II.	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Chicago gluten meal,	0.50 "	Chicago gluten meal,	0 50 "
Rowen,	2.00 "	Rowen,	1.00 "
Nutritive ratio,	1:4 50	Corn ensilage,	3.50 "
Total cost (approximate),	2.50 cts.	Nutritive ratio,	1:5 09
Manurial value obtainable,	1.15 "	Total cost (approximate),	2.24 cts.
Net cost,	1.36 "	Manurial value obtainable,	1.10 "
		Net cost,	1.14 "

III.		IV.	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Linseed meal,	0.25 "	Linseed meal,	0.25 "
Rowen,	1.50 "	Rowen,	0.50 "
Nutritive ratio,	1:4.0	Corn ensilage,	3.50 "
Total cost (approximate),	2.08 cts.	Nutritive ratio,	1:5.0
Manurial value obtainable,	1.02 "	Total cost (approximate),	1.8 cts.
Net cost,	1.06 "	Manurial value obtainable,	0.9 "
		Net cost,	0.9 "

V.		VI.	
Corn meal,	0.50 lbs.	Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0 50 "	Rowen,	2.00 lbs.
Rowen,	1.50 "	Nutritive ratio,	1:5.3
Nutritive ratio,	1:5.3	Total cost (approximate),	2.33 cts.
Total cost (approximate),	2 40 cts.	Manurial value obtainable,	1.25 "
Manurial value obtainable,	1.30 "	Net cost,	1.07 "
Net cost,	1.10 "		

VII.

Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0.25 "
Rowen,	0.50 "
Corn ensilage,	4.00 "
Nutritive ratio,	1:4.6
Total cost (approximate),	2.04 cts.
Manurial value obtainable,	1.14 "
Net cost	0.90 "

Linseed meal, cotton-seed meal and Chicago gluten meal can be substituted one for the other without very materially changing the cost of the ration or its feeding effect. Buffalo gluten feed and Chicago maize feed can also be used interchangeably.

One-half pound of rowen and four to five pounds of corn ensilage in a ration tend to cheapen the cost and are as effective in feeding value as one and one-half to two pounds of rowen. In general, four pounds of corn ensilage can be reckoned an equivalent for one pound of rowen, so far as dry matter is concerned.

The rations as given can be increased or decreased proportionately in quantity to suit the appetite and size of the animals fed.

III. Practical Rations for Pig Feeding.

When skim-milk is used as a part of the daily diet in feeding pigs for the market, the station feels justified, in view of its feeding experiments, in recommending the following practical rations as being valuable in producing pork at a minimum cost: —

I.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80,	2 ounces corn meal to each quart milk,*	1:3.30
80 to 125,	4 ounces corn meal to each quart milk,	1:4.00
125 to 190,	6 ounces corn meal to each quart milk,	1:4.50

* Creamery buttermilk can be substituted for skim-milk as above with good results if it can be had at a reasonable price, say 1.4 cents per gallon.

When skim-milk is in limited supply (from four to six quarts per pig), feed as follows: —

II.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	Milk at disposal, and one part by weight wheat bran, two parts by weight gluten meal, to satisfy appetite.	1:3.20
80 to 125, .	Milk at disposal and following mixture: one weight part corn meal, one weight part wheat bran, one weight part gluten meal, to satisfy animal.	1:4.00
125 to 190, .	Milk at disposal and following mixture: two weight parts corn meal, one weight part wheat bran, one weight part gluten meal.	1:4.50

III.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	2 ounces corn meal to each quart of milk and 4 ounces gluten feed as a substitute for each quart milk.	1:3.25 to 4.00
80 to 125, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one part by weight corn meal.	1:4.00 to 4.40
125 to 190, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one and one-half parts by weight corn meal.	1:4.4 to 4.9

IV. Rations for Farm Horses.

While we have never carried out any direct experiments with horses, the following rations, fed to our farm horses, have given very excellent results (basis 1,000 pounds live weight): —

(a) *Light Work (Winter).*

	Pounds.
Hay,	15
Wheat bran,	2
Provender,	4

(b) *Medium Work.*

	Pounds.
Hay,	15
Wheat bran,	3
Provender,	6

(c) *Hard Work.*

	Pounds.
Hay,	15
Wheat bran,	4
Provender,	8

The provender consists of cracked corn and oats, in the proportion of 400 pounds of the former to 15 bushels of the latter.

The following table shows the pounds of digestible nutrients in our ration for medium work, as compared with Wolff's for horses of 1,000 pounds live weight, doing medium work and hard work: —

	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbo-hydrates (Pounds)	Total Digestible Matter (Pounds).	Nutritive Ratio.
Medium work,	1.58	0.43	11.25	13.26	1 : 7.81
Wolff's standard, medium work,	1.55	0.55	10.85	12.95	1 : 7.80
Wolff's standard, hard work,	2.12	0.83	12.63	15.58	1 : 7.00

II.

OBJECTS OF THE FOLLOWING EXPERIMENTS.

III. Feeding Experiments with Milch Cows.

1. October to December, 1893.

To note the comparative feeding effects of English hay, hay of vetch and oats and soja bean and barley straw upon the production and cost of milk.

Grain feed was constant, and consisted of wheat bran, Buffalo gluten feed and new-process linseed meal.

2. January to May, 1894.

(*a*) To determine how much digestible protein can be economically fed to milch cows.

(*b*) To determine the effect of different quantities of protein upon the quantity and quality of the milk.

3. Creamery Record of the Station.

The tabulated results of the station herd for 1893 and 1894.

IV. Hay Substitutes.

A résumé of some experiments with vetch and oats and peas and oats, calling attention to their value for milk production, as compared with English hay.

V. The Babcock *v.* the Space System as a Basis for Payment in Massachusetts Creameries.

The object of this experiment is to call attention to the composition of cream from various patrons raised by the deep-setting process, in order to see if the payment for cream by the space (or fraction of an inch) is equally just to all parties. The Babcock method is contrasted with the space system.

VI. Feeding Experiments with Steers.

(*a*) To note the effect of distinct fodder rations upon the production of live weight.

(*b*) To secure facts relative to the actual cost of beef production in Massachusetts under existing local conditions.

(*c*) To compare the relative merits and cost of pasture *v.* soiling during the summer season. (A résumé of all our experiments with steers follows this experiment.)

VII. Feeding Calves for Veal.

(*a*) To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

(*b*) To see if such a mixture would fatten calves economically.

VIII. Digestion Experiments with Sheep.

1. To study the digestibility and consequent value as a source of food of a variety of concentrated cattle foods.

2. The digestibility of the pentosans. An investigation into the value as a source of food of a group of substances, called pentosans, found in most of our cattle foods, concerning which our knowledge heretofore has been very limited. This article at the present time has rather more of a scientific than practical interest.

III.

FEEDING EXPERIMENTS WITH MILCH COWS.

1. COMPARATIVE VALUE OF DIFFERENT COARSE FEEDS.

By J. B. Lindsey.

October–December, 1893.

[Grains fed: wheat bran, Buffalo gluten feed, new-process linseed meal. Coarse feeds: hay, dry vetch and oats, soja-bean hay and barley straw.]

Object of the Experiment.

To note the comparative effect of English hay, dry vetch and oats, soja-bean hay and barley straw upon the production and cost of milk.

Results of the Experiment.

The average cost of producing milk from six cows of the station herd in different periods of lactation was 2.3 cents per quart; the average yield was 9.46 quarts per day.

Hay of vetch and oats compared very favorably with English hay for milk production.

The composition of the milk was apparently not affected by the different coarse fodders.

The Experiment.

The analyses of the foods fed and their fertilizing value, the history and feeding record of the individual cows, etc., will be found at the end of the experiment.

Six cows were used in the trial; they were grades of various breeds in different periods of lactation, yielding from 7 to 15 quarts of milk daily.

The fodder articles were all in good condition, and may be considered fair samples of their kind.

During the entire feeding trial the grain ration remained constant, the coarse fodders alone being changed. The cows were fed, watered and milked twice daily, one-half the food being given at each feeding. They were allowed outdoor exercise on every pleasant day. They were weighed once a week, after the morning's feeding and milking but before being watered.

A composite sample of the milk was taken three days of each week during the trial, thus furnishing the average of every six milkings out of fourteen. This at least gives a good average for each week.

Average Composition of the Daily Fodder Rations (1893–94).

I.		II.	
October 5 to October 16.		*October 25 to November 27.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "	Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "	New-process linseed meal,	3.00 "
Hay,	17.63 "	Hay of vetch and oats,	16.52 "
Nutritive ratio,	1 : 4.40	Nutritive ratio,	1 : 4.20
Total cost,	22.97 cts.	Total cost,	22.14 cts.
Manurial value obtainable,	10.85 "	Manurial value obtainable,	11.28 "
Net cost,	12.12 "	Net cost,	10.86 "

III.	
December 9 to January 2.	
Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "
Soja-bean hay,	10.81 "
Barley straw,	4.56 "
Nutritive ratio,	1 : 4.13
Total cost,	20.14 cts.
Manurial value obtainable,	10.79 "
Net cost,	9.35 "

Three pounds wheat bran equal 4 quarts; 3 pounds Buffalo gluten feed equal 3 quarts; 3 pounds new-process linseed meal equal 2½ quarts.

The *total cost* of a fodder ration is the sum of the market costs of the different articles consumed per day. The *manurial value obtainable* is the value of the nitrogen, phosphoric acid and potash of the ration fed that will be found in the manure. In case of milch cows this amounts on an average to 80 per cent. of the fertilizing ingredients contained in the feed. The other 20 per cent. goes into the milk or flesh of the animal. The value of the nitrogen, phosphoric acid and potash thus excreted is based upon the retail cost of these articles in the open markets. When the experiment was in operation this amounted to 15 cents per pound for nitrogen, 5½ cents per pound for phosphoric acid and 4½ cents per pound for potash. The *net cost* of a ration is that cost remaining after the value of the manure has been deducted from the total cost.

Quantity and Cost of Milk produced Daily.

FEEDING PERIODS.	NETTIE.		JENNIE.		GEM.		JULIA.		NORA.		NELLIE.		AVERAGE.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
I., . .	14.40	1.61	6.82	3.19	8.87	2.62	8.64	2.69	8.82	2.64	13.77	1.67	10.22	2.25
II., . .	12.69	1.87	5.88	3.47	9.14	2.42	8.46	2.62	8.26	2.69	12.17	1.82	9.43	2.35
III., . .	11.24	1.81	5.11	3.72	8.85	2.36	7.53	2.80	8.10	2.44	11.54	1.71	8.73	2.31

If we notice the averages in the above table, it will be seen that the cows declined slightly and regularly in the yield of milk during the three months of trial. There was a decrease of 7.8 per cent. in the milk production between the first and second periods and a further decrease of 6.8 per cent. between the second and third periods, making a total decrease of 14.6 per cent. during the three months of trial. This is by no means excessive. Five of the six cows gave an average increase of 19 pounds each in live weight during the vetch and oats period. When it is also remembered in cases of the hay and the vetch and oats periods that the former lasted but 12 days and the latter 34 days, the difference in yield in favor of the hay would be still further reduced. The cost of feed per quart of milk is about the same in all three periods, a very slight difference in favor of the hay period being observed, which would probably be counterbalanced when the longer vetch and oats period and the natural decline in yield are considered. The vetch and oats hay compared, then, quite well with the first cut hay of upland meadows.

While the soja-bean hay and barley straw compared very favorably with the other coarse fodders, it is hardly to be commended, because of the tendency of the bean leaves of the soja-bean plant, like all leguminous crops, to dry up and fall off in the process of curing. The soja bean can be much better preserved in the silo mixed with corn fodder.

Quality of Milk Produced.

Feeding Periods.	Rations.	Nettie.		Jennie.		Gem.		Julia.		Nora.		Nellie.	
		Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.
I. 12 days.	Grain and hay,	12.17	3.62	15.11	5.81	13.38	4.76	14.94	5.75	13.54	4.60	15.78	6.60
	Grain and hay,	12.71	3.95	15.26	5.80	13.29	4.55	14.57	5.72	13.46	4.20	13.31	4.00
	Average,	**12.44**	**3.79**	**15.19**	**5.81**	**13.34**	**4.66**	**14.76**	**5.74**	**13.50**	**4.40**	**14.55**	**5.30**
II. 34 days.	Grain and hay of vetch and oats,	12.40	3.90	16.16	6.20	13.85	4.78	13.81	4.60	13.66	4.40	14.26	5.10
	Grain and hay of vetch and oats,	12.59	3.43	16.69	6.40	14.08	5.00	13.78	3.98	12.29	2.93	13.56	3.73
	Grain and hay of vetch and oats,	12.80	3.85	16.84	6.45	13.24	4.15	14.34	4.43	13.42	3.82	13.81	3.80
	Grain and hay of vetch and oats,	13.07	3.80	15.64	5.43	13.61	4.50	14.28	4.65	13.24	3.60	13.83	3.80
	Grain and hay of vetch and oats,	13.23	3.90	15.39	5.40	13.39	4.40	14.39	5.00	13.53	4.20	14.20	4.30
	Average,	**12.82**	**3.78**	**16.14**	**5.98**	**13.63**	**4.57**	**14.12**	**4.53**	**13.23**	**3.79**	**13.93**	**4.15**
III.* 25 days.	Grain, soja-bean hay and barley straw,	12.81	3.40	15.63	5.78	13.40	4.40	14.09	4.63	13.35	3.75	13.54	3.60
	Grain, soja-bean hay and barley straw,	12.58	3.60	16.07	6.30	13.43	4.50	14.46	5.00	13.54	4.00	14.15	4.25
	Grain, soja-bean hay and barley straw,	13.16	4.30	16.05	6.30	13.25	4.40	14.32	5.00	13.10	4.05	13.94	4.30
	Average,	**12.85**	**3.77**	**15.92**	**6.13**	**13.36**	**4.43**	**14.29**	**4.88**	**13.33**	**3.93**	**13.88**	**4.05**

* In the cases of Jennie and Julia the third period lasted only 20½ days.

In case of cows Nettie, Jennie and Gem the percentage of solids and fat remained very constant during the three periods, while the solids and fat of the milk of cows Julia, Nora and Nellie show a decrease in the last two periods. This decrease can only be explained on the ground that the change of feed interfered for a time with the process of secretion. Towards the end of each period it is noted that the composition of the milk of two of three cows approached that of the first period again. Cows Nora and Nellie seemed for quite a while to produce milk of a varying fat content.

DETAILS OF THE EXPERIMENT.

FEEDING RECORD.

Nettie.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.					
1893-94.												
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	14.40	1.62	1:4.45	882
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	18.71	–	–	23.65	12.69	1.86	1:4.40	917
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	11.24	4.41	21.32	11.24	1.90	1:4.10	907

Jennie.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	16.00	–	–	–	21.66	6.82	3.18	1:4.20	806
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	14.21	–	–	19.90	5.88	3.38	1:4.10	818
Dec. 9 to Dec. 29,* . .	2.78	2.78	2.78	–	–	9.43	4.29	19.70	5.11	3.86	1:4.00	831

Gem.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.87	2.63	1:4.45	1,070
Oct 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.53	–	–	21.83	9.14	2.39	1: 4.20	1,087
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	11.82	4.61	22.00	8.85	2.49	1:4.20	1,080

Julia.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.64	2.70	1:4.45	873
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.51	–	–	21.82	8.46	2.58	1:4.20	891
Dec. 9 to Dec. 29,* . .	3.00	3.00	3.00	–	–	11.97	4.66	22.15	7.53	2.94	1:4.20	899

Nora.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.82	2.65	1:4.45	809
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.60	–	–	21.89	8.26	2.65	1:4.20	821
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	10.19	4.68	20.68	8.10	2.55	1:4.00	832

Nellie.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	17.75	–	–	–	23.15	13.77	1.68	1:4.40	902
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.56	–	–	21.86	12.17	1.80	1:4.20	882
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	10.20	4.68	20.69	11.54	1.79	1:4.00	851

* Sold.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie,	Grade Holstein,	5	July 2, 1893,	15
Jennie,	Grade Jersey,	4	Dec. 25, 1892,	7
Gem,	Grade Shorthorn,	6	Dec. 6, 1891,	8–9
Julia,	Native,	9	Jan 18, 1893,	9-10
Nora,	Grade Ayrshire,	5	Mar. 25, 1893,	10
Nellie,	Native,	8	Aug. 15, 1893,	14

Local Market Cost, per Ton, of the Various Articles of Fodder Fed.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
New-process linseed meal,	27 00
Hay,	15 00
Hay of vetch and oats,	15 00
Soja-bean hay,	15 00
Barley straw,	10 00

Analyses of Fodder Articles.

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture at 100° C.,	12.42	8.30	10.62	15.00	16.67	16.21	12.80
Dry matter,	87.58	91.70	89.38	85.00	83.33	83.79	87.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.10	0.91	5.89	7.83	11.38	12.62	4.94
" cellulose,	11.06	7.96	8.84	32.74	30.15	27.73	39.84
" fat,	6.10	14.25	3.94	3.08	3.45	2.55	2.49
" protein,	18.29	22.48	40.79	10.79	13.51	14.89	6.21
Nitrogen-free extract,	58.45	54.40	40.54	45.56	41.51	42.21	46.52
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Crude cellulose, . . .	25	43	61	60	66	58	56
" fat, ...	72	81	91	49	19	14	42
" protein, . . .	78	85	87	60	60	64	20
Nitrogen-free extract, . .	68	81	86	60	54	61	54

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture, ...	12.42	7.32	10.89	15.00	16.67	16.21	12.80
Nitrogen, ...	2.56	3.33	5.83	1.47	1.81	2.00	0.86
Phosphoric acid, . . .	2.46	0.37	1.95	0.27	0.50	0.50	0.12
Potassium oxide, . . .	1.60	0.11	1.08	1.50	1.24	1.24	2.60
Valuation per 2,000 pounds,	$13 18	$12 15	$23 55	$7 07	$8 20	$8 86	$5 99
Manurial value obtainable, .	10 54	9 72	18 84	5 66	6 56	7 09	4 79

2. EFFECT OF FOOD UPON THE COST AND QUALITY OF MILK.

By J. B. Lindsey.

January–May, 1894.

Objects of the Experiment.

I. To determine how much digestible protein can be economically fed to milch cows.

II. To determine the effect of different quantities of protein upon the quantity and quality of the milk.

Brief Explanation of the Objects Sought.

By digestible protein is meant the nitrogenous part of the food consumed and digested. The non-nitrogenous part, *i.e.*, that which is not protein, is the cellulose, starch, sugars, gums and fatty substances.

Very much is being said at the present time by our experiment stations and intelligent dairy farmers about the value of different rations for the dairy cow. What is the most suitable nutritive ratio * of these fodder rations, or how much protein shall be fed in the ration, is a question of economical importance, for the protein is the most costly of all the fodder constituents.

Again, the writer deems it advisable, partly as an object lesson and partly for more light on the subject, — recognizing at the same time the work already accomplished, — to note the effects of different amounts of protein upon the composition or quality of the milk.

General Teachings of the Experiment.

1. The amount of protein fed in the various fodder rations varied from 1.3 to 3.76 pounds daily to cows averaging 871 pounds live weight. The ration containing the most protein produced milk at a less cost per quart in each

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* By nutritive ratio is meant the proportion which the nitrogenous bears to the non-nitrogenous part of the food.

of the three series of experiments, besides furnishing a better quality of manure.

2. During the autumn, winter and spring months from 2.5 to 3 pounds of protein can be fed daily to dairy cows in good condition (on a basis of 1,000 pounds live weight) with economy and consequent profit. During the summer months it might not be advisable to feed over 2.5 pounds of digestible protein in the fodder ration in case of stall-fed cows, and one should be especially careful at that season about feeding grains containing an excess of fat (see caution elsewhere).

3. When as low as 1.3 pounds of protein were fed daily, the total digestible organic matter at the same time being sufficient for the animal's daily needs, the quality of the milk, especially its fat content, was below that produced by a ration containing 2.5 to 3 pounds of digestible protein.

4. When 3 pounds of protein were fed in the daily ration there was an indication that its influence upon the quality of the milk ceased to be felt.*

5. All of the cows were not affected alike by the same fodder ration.

6. The total solid matter in the milk was much less affected than the fat.

7. This experiment points out the economy of feeding properly balanced rations in order to secure maximum and long-continued milk yields, as well as the best quality of manure.

GENERAL INTRODUCTION.

The German investigator, E. von Wolff,† who has closely studied the results of all German investigators concerning the most suitable fodder rations for milch cows, has given the following standard ration on a basis of 1,000 pounds live weight: —

Digestible protein,	2.50 lbs.
Digestible fat,	0.60 "
Digestible carbohydrates,	13.00 "
Nutritive ratio,	1:5.4

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* It is hoped that it will be possible to still further study this question of the effect of food and especially protein upon the quality and quantity of the milk produced.

† Die Ernährung der Landwirthschaftliche Nützthiere, 1876, p. 548.

He claims that about 2.5 pounds of digestible protein should be contained in the ration fed in order to keep the animal in good condition and to keep up the quantity of milk for the longest possible time.

Märcker and Morgen,* as a result of their experiments with five different herds of cows, claim that more protein than the current usage and feeding standards call for can be economically fed, thus: —

	I.	II.
Digestible protein (pounds),	4.06	3.42
Digestible fat (pounds),	0.60	0.50
Digestible carbohydrates (pounds),	13.80	13.84
Nutritive ratio,	1:3.8	1:4.4

While this might be economically true in sections of Germany, it does not necessarily hold that it is economically true in Massachusetts.

Woll † has made quite a thorough inquiry into the rations fed by successful dairymen in different sections of the United States, and calls the average of his results the American standard ration, which he believes to be correct for the larger part of the United States. It is as follows: —

Digestible protein,	2.15 lbs.
Digestible fat,	0.74 "
Digestible carbohydrates,	13.27 "
Nutritive ratio,	1:6.9

He furnishes no results of experiments to prove this to be the case, simply basing his conclusion upon the opinion of dairy farmers. Whether the judgment of dairy farmers is correct or not we will not at this point express an opinion, but it seems to the writer a rather peculiar position for a scientific inquirer to take.

During the winters of 1892–93 and 1893–94 Messrs. Woods and Phelps ‡ made investigations concerning the fodder rations fed by many prominent dairymen in Connecticut, and found them containing about 2.5 pounds of digestible protein and 17.5 pounds of total digestible nutrients. Where rations poorer in protein were fed than the above, the milk produced was noted, then a change in the ration was suggested, and later the production of the herd was again accurately observed.

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* Résumé in Experiment Station Record, March, 1892.

† Bulletin No. 38, Wisconsin Experiment Station.

‡ Bulletin No. 13, Storr's Experiment Station.

They recommended, as a "tentative ration," 2.5 pounds of digestible protein and 16 pounds of total digestible organic matter, — practically the German standard.

The many experiments already carried out at the Massachusetts station have shown the economy of feeding at least 2.5 pounds of digestible protein in the daily ration.

There appears, however, to be a difference in opinion as to the amount of protein that can be *economically fed* to our dairy cows, and the investigation that follows is a step towards the solution of the problem.

In the second place, we have endeavored to note if the varying amounts of protein in rations that contain sufficient total digestible organic nutrients have had any noticeable effect upon the *quality* of the milk produced.

E. Wolff * and G. Kühn † during the years 1868–76 made this subject a special study. The results of their investigation may be stated concisely as follows: —

That milk production is dependent, in the first place, upon the individuality of the cow and upon the development of the milk glands. It is impossible to radically change the composition of the milk by means of food, to transform a "butter cow" into a "cheese cow" at will, etc. On the other hand, there are cows whose milk can be influenced by the foods fed, but only to a limited degree. In the thirty cows that were accurately studied there were only two where such an influence of the fodder was decidedly proved. With some of the other cows very slight changes only were noticed. Of all the milk components, the fat was by far the most influenced by the food supply.

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* E. Wolff, "Die Verssuchsstation Hohenheim," Berlin, 1870.

† Journal für Landw , 1874; Landw. Verssuchsstation, 1869; Résumé in Die Ernährung der Landwirthschaftliche Nützthiere, E. Wolff, 1876.

The one-sided increase in the milk fat in case of individual cows was parallel with the increased supply of digestible protein. Different concentrated feeds appeared also to have increased the percentage of fat.* A previously well-fed cow, fed so as to be poorly nourished,† would decrease in her flow, and the quality of the milk would be, as a rule, gradually impaired, though not radically affected. Upon these experiments of Wolff and Kühn is based our present knowledge of the subject under consideration.

In 1891 W. Fleischmann ‡ presented the results of his studies upon a large herd of cows. He did not study this especial point, namely, the effect of increasing amounts of protein on the quality of the milk; but he makes, in connection with his conclusions, the following interesting observation: "The fact long believed to be true in practice, namely, the increasing the amount of food nutrients to make the milk of cows richer in fat absolutely as well as relatively, would seem to be fully confirmed."

Kochs and Ramm § studied this subject in 1891, using three cows of different breeds, and concluded that in case of their experiment the food had no effect upon the fat content of the milk.

From 2.2 to 4.4 pounds of digestible true protein were fed daily, and approximately 21 to 23 pounds of total digestible organic matter, on the basis of 1,000 pounds live weight. The weakness of this experiment is at least twofold: first, because of the few cows used; and second, because each cow was not fed with the exact ration belonging to her, but the entire food weighed out for the three cows was given to them collectively.

It will be noticed that the smallest amount of protein was 2.25 pounds. The amount of total digestible organic matter fed was, however, above Wolff's standard, so that the nutritive ratio was 1 : 8.00.

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* Palmnut meal and bean meal.

† I wish to state that a milch cow can be poorly nourished in two ways: first, by not getting sufficient food to eat; and second, while she may get enough to eat, the food for milk production might be what is termed an improperly balanced one. Hay, for example, contains a large excess of carbohydrates and not enough protein.

‡ Landw., Jahrb., 20, 1891, Supplement II; Résumé in Experiment Station Record, Vol. III, p. 424.

§ Landw., Jahrb., Bd. xxi, 1892, p. 809.

W. H. Jordan * gives the results of several trials. In the first experiment three cows were used. The animals were fed in the second period of 14 days on hay and corn meal, and in the first and third periods 2 pounds of cotton-seed meal were substituted for 2 pounds of corn meal. Otherwise the food was alike in all three periods. The corn meal ration contained .87 pound of digestible protein and 12.45 pounds total digestible organic nutrients for cows weighing 925 to 950 pounds, — clearly an insufficient amount, as the experimenter states. The cotton-seed ration contained 1.47 pounds of digestible protein and 12.41 pounds of total digestible organic nutrients, also insufficient in quantity, but still somewhat improved. Two of three cows showed a slight increase in the solid matter of the milk on the cotton-seed ration, and one a decrease. The percentage of fat in the milk of the same two cows, on a basis of 13 per cent. total solid matter, was quite uniform for all three periods. The milk of the cow that showed a decrease in per cent. of solid matter on the cotton-seed ration showed at the same time a slight decrease in the fat percentage, on the basis of 13 per cent. total solids.

We have here another example of how different cows are differently affected by similar foods. This experiment was repeated the next year with four cows, but as far as the components of the milk were concerned very little change was noted.

In 1893 the same investigator published the results of experiments with three cows. The total digestible nutrients fed were sufficient, and each period lasted 35 days. The milk was analyzed the last five days of each period.

The writer thinks it would have been better to have had the results of the composition of the milk for five days of each week for every period.

Only the very briefest résumé is here given: —

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* Maine Experiment Station, reports for 1885–86, 1886–87, 1893.

	Protein. Pounds fed.	TOTAL SOLIDS IN MILK OF COWS.			
		Cow A.	Cow R.	Cow L. S.	Average, Three Cows.
		Per cent.	Per cent.	Per cent.	Per cent.
Wide ration, ...	1.18	13.39	13.64	13.50	13.51
Narrow ration, . . .	2.09	14.11	13.92	14.27	14.10
Percentage increase of narrow over wide ration, . .	–	–	–	–	**4.37**

Per Cent. of Fat in Milk on a Basis of Fourteen Per Cent. Solids.

Wide ration, ...	1.18	4.43	4.45	4.43	4.43
Narrow ration, . . .	2.09	4.68	4.77	4.72	4.73
Percentage increase of narrow over wide ration, . .	–	**5.64**	**7.19**	**6.54**	**6.50**

This experiment would indicate that the increase of protein in the food had somewhat increased the per cent. of fat in the milk.

The experimenter draws the following conclusion: "In general, the milk was richer while the cows were fed the ration rich in protein, though with one cow it showed the largest per cent. of solids during the third period, while she was eating the corn-meal ration.

"In general, the proportion of fat increased throughout the experiment, without regard to what the cows were fed, and no evidence is furnished in support of the notion that by changing the food it is possible to produce more butter fat without an accompanying increased production of other milk solids."

Armsby * carried out similar experiments with three cows during the years 1885 and 1886. The digestible protein fed during 1885 was from 1.5 to 2 pounds daily and the total digestible organic nutrients 13.5 pounds daily to cows of about 850 pounds live weight. These rations were sufficient in quantity. During 1886 1.1 to 1.8 pounds digestible protein and 12.7 pounds of total organic nutrients were fed. The weight of the animals is not given, but probably they were about the same as in the previous experiment. Armsby failed to find any change in the composition of the milk that could be traced to food influence.

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* Wisconsin Experiment Station, reports for 1885 and 1886.

The New Hampshire Experiment Station * failed to note any decided improvement in the quality of the milk when rations containing sufficient digestible organic nutrients were fed, by varying the digestible protein from 2 to 3 pounds daily.

The Iowa Experiment Station in 1891 published the results of an experiment made "to determine the effect of food upon the quality of milk," without apparently endeavoring to note the effect of any particular group of constituents in the fodder ration. They compared the effect of corn meal (low in protein) with gluten meal (high in protein). They really fed one ration containing but 1.05 pounds of digestible protein and another containing 2.18 pounds. Four cows, averaging 1,000 pounds in live weight, were used in the experiment, — three grade Shorthorn and one grade Holstein. It is impossible, for lack of data, to calculate accurately the amount of digestible nutrients fed, but an attempt has been made below to get an approximate idea. It appears that neither the corn fodder nor the clover hay was tested for moisture or subjected to analysis.

Ration I.		Ration II.	
	Pounds.		Pounds.
Corn and cob meal, . .	12½	Sugar (gluten) meal, .	10
Corn fodder, . . .	12	Corn fodder, . . .	12
Clover hay, . . .	4	Clover hay, . . .	4

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* Bulletins 9 and 10.

	Ration I.	Ration II.	Per Cent. Increase of II. over I.
Digestible protein (pounds), . . .	1.05	2.18	–
Total nutrients fed (pounds), . . .	14.09	13.51	–
Nutritive ratio, ...	1:13.10	1:5.71	–
Total yield of milk (pounds), . . .	3,302.50	3,399.50	2.94
Total solids (pounds), ...	392.08	428.21	9.21
Fat (pounds), ...	111.25	134.39	20.80
Per cent. of solids in milk, . . .	11.93	12.63	5.87
Per cent. of fat in milk, ...	3.37	3.94	16.90
Milk on basis of 12 per cent. total solids (pounds).	3,283.20	3,578.00	8.97
Fat, per cent., basis 12 per cent. solids, .	3.39	3.74	10.32

So far as one is able to judge from the data presented, these rations, other things being equal, were not sufficient for cows of 1,000 pounds live weight that had had calves but a short time previous to the experiment, and yielding 12 to 15 quarts of milk daily. They should apparently have received at least 3 pounds more of total digestible organic matter daily. This insufficient food would of itself have had a tendency to produce a poor quality of milk. In the corn and cob meal ration the protein supply was quite low, and it is surprising that the animals did not shrink more than 9 per cent. in their yield of milk on the basis of 12 per cent. solids below the sugar-meal ration. The milk of Ration I. shows the effect not only of lack of protein but of lack of sufficient food as well. In the sugar-meal ration the replacing of a pound of carbohydrates by a pound of protein is seen in the increase of the solid matter, and especially of the amount of fat. The weight of the animals at the beginning and end of the periods (21 days) is not given, but it is stated that "the variations were not greater than usually appear in the live weight of such animals, and did not surely indicate gain or loss."

It hardly seems possible to the writer that animals fresh in milk, with an average weight of 1,000 pounds, could be fed on such a food combination as Ration I. and not show the effect of it in a very short time. The data given show that the quantity of the milk was increased and the quality improved, especially its fat content, by increasing the supply of protein in the daily ration. The poor quality of the milk in Ration I. was due in all probability partly to the lack of food and partly to the small amount of protein present. The experiment teaches nothing new, as the investigators seem to think. It has long been recognized that when insufficient rations are fed, and they are at the same time especially lacking in protein, the milk of many cows will show a decrease in quality. The fat has a tendency to be more affected than the other ingredients.

The experiment made at the Massachusetts State Experiment Station about to be described in the following pages is intended first as an object lesson to our dairymen, and secondly it was made with a view of obtaining additional information of an economical as well as of a scientific nature upon this still somewhat disputed question.

PLAN OF THE EXPERIMENT.

The experiment was divided into three periods, known as Series I., II. and III. The preliminary feeding generally lasted seven days, and the period itself fourteen. In Series I. it required longer than seven days to get the cows accustomed to the ensilage. In Series III. *a* and *b*, the periods themselves lasted but nine days.

The distinct rations fed will be stated further on. In Series I. *a*, 2.58 pounds of protein (N.R. 1 : 4.8) were fed, and in Series I. *b*, 1.31 pounds of protein (N.R. 1 : 10). The ration *b* represents the way a great many New England farmers feed, while ration *a* is not far from the German standard. In Series II. *a*, 2.55 pounds of protein were fed, essentially the same as in Series I. *a;* and in Series II. *b*, 2.24 pounds of protein (N.R. 1 : 5.8) were fed, rather less in amount, and furnishing, consequently, a somewhat wider nutritive ratio. In this period also we get a direct comparison of the relative effect of Buffalo gluten feed and corn meal. In Series III. *a*, 2.91 pounds of protein (N.R. 1 : 4.4) were fed, and in Series III. *b*, 3.76 pounds of protein were fed, being relatively large amounts of protein with correspondingly narrow rations.

Strictly speaking, these series, so far as the yield of milk is concerned, can be compared only with themselves, but not with each other, for Series I. *a* and *b* was in operation during the latter part of January and the first half of February, Series II. *a* and *b* was completed about the end of March, and Series III. *a* and *b* about May 1. During this time the cows would naturally shrink some in their milk yield. In order to overcome so far as possible the natural milk shrinkage in comparing the effect of the rations in the three series on the total yield from the herd, the following plan was adopted: take, for example, Series I. *a* and *b*. Cows 1, 2 and 3 were fed the narrow ration, Series I. *a*, during the two weeks that cows 4, 5 and 6 received the wide ration, Series I. *b;* and then the operation was reversed, cows 1, 2 and 3 receiving the wide ration, Series I. *b*, while cows 4, 5 and 6 received the narrow ration, Series I. *a*. This plan was continued through the entire series.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie, . .	Grade Holstein, .	8	July, 1893,	11
Mary, . .	Grade Durham, .	8	Dec. 17, 1894,	12
Gem, . .	Grade Shorthorn, .	6	Dec. 6, 1891,	9
Sarah, . .	Grade Jersey,. .	6	Dec., 1893,	8½
Nora, . .	Grade Ayrshire, .	6	Mar. 25, 1893,	7
Nellie, . .	Native, . . .	9	Aug. 15, 1893,	10½
Hattie, . .	Grade Jersey, .	6	Mar. 23, 1894,	13

The cows were six in number; during the last period Hattie was substituted for Sarah.

What the Cows were Fed.

In Series I. and II. the coarse fodder consisted of 3 to 4 pounds of dry corn stover and corn ensilage *ad libitum.* The corn ensilage was made from Pride of the North corn, and was cut and put in the silo when the kernels were glazing. It was of good quality. In Series III. the coarse fodder consisted of corn stover and a good quality of rowen.

The grains consisted of wheat bran, corn meal, Buffalo gluten feed, cotton-seed meal and Chicago gluten meal, all of good quality. One ounce of salt was fed daily. Its beneficial effect upon the appetite and circulation is generally acknowledged.

How the Cows were Fed and Kept.

The food was given in two portions, one-half about six o'clock in the morning and the other about four o'clock in the afternoon. The grains were fed dry. The cows were watered twice daily, after eating in the morning and before eating in the afternoon. The animals were well carded and allowed several hours' exercise in the yard whenever weather permitted. The animals were weighed weekly, in the morning before being watered.

Sampling the Milk.

A composite sample of the milk was made for three days of each week (six milkings), and this was taken to represent the average composition of the milk for the week.

*Average Composition of the Daily Fodder Rations (1894).**

Series I.†

a.		*b.*	
Wheat bran,	3.00 lbs.	Wheat bran,	4.50 lbs.
Buffalo gluten feed,	3.00 "	Corn meal,	4.50 "
Cotton-seed meal,	3.00 "	Corn stover,	4.00 "
Corn stover,	4.00 "	Corn ensilage,	43.50 "
Corn ensilage,	42.78 "	Nutritive ratio,	1 : 10
Nutritive ratio,	1 : 4.80	Total cost,	14.99 cts.
Total cost,	15.95 cts.	Manurial value obtainable,	5.84 "
Manurial value obtainable,	8.46 "	Net cost,	9.15 "
Net cost,	7.46 "		

* See digestible nutrients fed to each cow, further on.

† Periods 14 days long.

Average Composition of the Daily Fodder Rations — Concluded.

SERIES II.*

a.		*b.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "	Cotton-seed meal,	3.00 "
Cotton-seed meal,	3.00 "	Corn meal,	3.00 "
Corn stover,	4.00 "	Corn stover,	4.00 "
Corn ensilage,	42.97 "	Corn ensilage,	46.41 "
Nutritive ratio,	1 : 4.8	Nutritive ratio,	1 : 5 8
Total cost,	15.97 cts.	Total cost,	16.40 cts.
Manurial value obtainable,	8 47 "	Manurial value obtainable,	8.00 "
Net cost,	7.50 "	Net cost,	8.40 "

SERIES III.†

a.		*b.*	
Wheat bran,	3.00 lbs.	Buffalo gluten feed,	3.00 lbs.
Cotton-seed meal,	3.00 "	Chicago gluten meal,	3.00 "
Corn meal,	3.00 "	Cotton-seed meal,	3.00 "
Rowen,	9.00 "	Rowen,	14.00 "
Corn stover,	6.56 "	Corn stover,	4.00 "
Nutritive ratio,	1 : 4.14	Nutritive ratio,	1 : 3.06
Total cost,	19 38 cts.	Total cost,	20.13 cts.
Manurial value obtainable,	10.12 "	Manurial value obtainable,	11.13 "
Net cost,	9.26 "	Net cost,	9.00 "

* Periods 14 days long. † Periods 9 days long.

Dates of the Series.

	SERIES I. *a.*	SERIES I. *b.*
Jan. 16 to Jan. 29,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
Feb. 6 to Feb. 19,	Cows 4, 5 and 6.	Cows 1, 2 and 3.
	SERIES II. *a.*	SERIES II. *b.*
Feb. 27 to March 12,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
March 19 to April 1,	Cows 4, 5 and 6.	Cows 1, 2 and 3.
	SERIES III. *a.*	SERIES III. *b.*
April 8 to April 16,	Cows 1, 2 and 3.	Cows 4, 5 and 6.
April 22 to April 30,	Cows 4, 5 and 6.	Cows 1, 2 and 3.

TABLE I.

(*a*) *Result of the Inquiry as to the Amount of Protein that can be Economically fed to Milch Cows daily.*

Quantity and Cost of Milk produced per Day.

FEEDING PERIODS.	NETTIE.		MARY.		GEM.		SARAH.		NORA.		NELLIE.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
Series I. *a*,	11.54	1.42	11.16	1.39	9.48	1.67	8.75	1.71	7.81	2.08	10.81	1.51
Series I. *b*,	9.65	1.55	9.75	1.65	8.40	1.78	8.32	1.66	7.26	2.08	10.65	1.41
Series II. *a*,	10.61	1.53	10.21	1.70	9.32	1.69	7.21	2.01	7.04	2.20	9.32	1.66
Series II. *b*,	9.45	1.73	8.26	2.12	8.54	1.02	7.94	1.95	7.29	2.30	10.32	1.60
Series III. *a*,	8.37	2.18	6.87	2.65	7.47	2.41	*13.75	1.50	7.24	2.85	8.92	2.31
Series III. *b*,	10.36	2.07	8.94	2.52	9.22	2.32	13.28	1.40	7.34	2.55	9.17	2.05

* Hattie, new cow.

TABLE II.

Summary for the Six Cows.

FEEDING PERIODS.	Pounds Protein fed Daily.	Average Weight.	Total Yield of Milk.	Total Cost per Quart.	Net Cost per Quart.	Total Amount of Butter Fat.	Total Cost per Pound.
		Pounds.	Quarts.	Cents.	Cents.	Pounds.	Cents.
Series I. *a*,* .	2.60	878	837.56	1.60	0.77	82.17	16.30
Series I. *b*,* .	1.30	867	756.51	1.66	1.02	67.37	18.67
Series II. *a*,* .	2.55	871	758.60	1.77	0.84	78.20	17.12
Series II. *b*,* .	2.24	873	725.04	1.90	0.97	70.09	19.66
Series III. *a*,† .	2.91	874	473.44	2.21	1.06	45.25	23.12
Series III. *b*,† .	3.76	862	524.94	2.11	0.93	50.95	21.69

* Period 14 days. † Period 9 days.

The above summary furnishes some very instructive lessons.

Series I. a and b.

Series I. *b* shows how a great many farmers feed. The ration contained some corn stover, with corn ensilage *ad libitum*, and 4.5 pounds each of wheat bran and corn meal.

This ration contains but 1.3 pounds of digestible protein. Series I. *a* shows a properly balanced ration, consisting of the same coarse fodders as *b* and three pounds each of wheat bran, Buffalo gluten feed and cotton-seed meal. The approximate total cost of *b* was 15 cents and the net cost 9.15 cents, while the total cost of ration *a* was 16 cents and the net cost 7.5 cents. While the total cost of ration *a* was a trifle more, the net cost was fully 1.5 cents less, due to the fact that this ration furnished a much better manure.

Ration *a* produced 837.5 quarts of milk, at a total cost of 1.6 cents per quart; and ration *b* produced 756.5 quarts of milk, at a total cost of 1.66 cents per quart. Note also that the net cost of a quart of milk in ration *a* was .72 cent and in ration *b* 1.02 cents. Thus not only were 81 quarts more of milk produced during the ration *a* period, but both the total and net cost of the milk were less.

Again, ration *a* produced 82.17 pounds of butter fat, and at a cost of 16.3 cents per pound; while ration *b* produced but 67.37 pounds, at a cost of 18.67 cents per pound. Whether or not the quality of the milk was affected by the different foods will be discussed further on.

The six cows fed on ration *b* showed an average decrease of eleven pounds in live weight. It is certain, however, that more flesh and fat were lost than the scales specified, for during Series I. *b* the animals looked thin and had every appearance of being improperly nourished. In all probability flesh and fat were replaced by water. It is very clear, then, that a ration containing 2.60 pounds of protein was more economical to feed than one containing approximately one-half that amount. This experiment deserves the serious attention of our farmers.

Series II. a and b.

This series can hardly be compared with Series I., as it was later and the animals had naturally shrunk some in their milk production. In ration *a* 2.55 pounds of protein were fed and in ration *b* 2.24 pounds, the only difference in the grain ration being that in ration *b* 3 pounds of corn meal took the place of 3 pounds of Buffalo gluten feed. The live weight of the animals remained constant during this series.

In ration *a* 35 quarts more of milk were produced, at .13 cent less per quart than in ration *b*. The net cost of the milk was correspondingly less. In ration *a* also 8 pounds more of butter fat were produced at 1.5 cents less per pound. These figures show the butter and milk producing power of the Buffalo gluten feed over the corn meal, or, more correctly speaking, the influence of even .25 pound more of digestible protein and also possibly the effect of the increased fat, in the daily fodder ration.

Series III. a and b.

The periods in this series lasted only nine days. In ration *a* 2.91 pounds of digestible protein were fed and in ration *b* 3.76 pounds. Here again we see the influence of the extra amount of protein in the fact that 51 quarts more of milk were produced during the nine-day period (equivalent to 78 quarts during 14 days), at .1 cent less per quart. The net cost of the milk in ration *a* was correspondingly less. In ration *a* 5.7 pounds more of butter fat were produced than in ration *b*, at 1.43 cents less per pound.

So far, then, as this one set of experiments is concerned, the largest amount of protein fed daily, viz., 3.76 pounds, was the most economical. It must be admitted that in feeding so much protein the animal is asked to do her best, and it is a question for how long a time she would be able to continue. The writer believes, however, that during the late fall and winter months cows that are in good condition can be fed from 2.5 to 3 pounds of digestible protein daily with profit. It probably would not be advisable to feed over 2.5 pounds daily to animals that are soiled during the spring, summer and early autumn.

Farmers are especially cautioned not to feed too large an amount of grain during the summer that contains a high percentage of fat. A large amount of fat in the daily ration at this season tends to overheat the animal and produce inflammation of the milk glands. Among such grains may be mentioned cotton-seed meal, Buffalo gluten feed, cream gluten meal, King gluten meal, etc. Not above 4 to 5 quarts of the Buffalo gluten feed or 2 quarts of any of the others should enter into any one daily grain ration during the summer months.

While 2.5 pounds or more of protein have been shown to be economical in the present experiment, the writer believes, with Wolff, that it is also *necessary to keep up the flow of milk for the longest possible time.* The demands upon the cow that produces 10 to 12 quarts of milk daily are severe, and she must be well supplied with sufficient digestible protein to meet these demands.

TABLE III.

(*b*) *Effect of Food (Protein) upon the Quality of the Milk.*

Quality of Milk Produced.

FEEDING PERIODS.	NETTIE.				MARY.				GEM.				SARAH.				NORA.				NELLIE.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*, . .	12.97	4.05	8.92	1:2.20	14.14	5.00	9.14	1:1.83	13.23	4.60	8.63	1:1.88	13.83	4.40	9.43	1:2.14	13.84	4.20	9.64	1:2.30	14.13	4.50	9.63	1:2.14
Series I. *a*, . .	13.23	4.30	8.93	1:2.08	14.11	5.20	8.91	1:1.71	13.38	4.78	8.60	1:1.80	13.72	4.83	8.89	1:1.84	13.72	4.83	8.89	1:1.84	14.12	4.05	10.07	1:2.49
Average, .	13.10	4.18	8.92	1:2.13	14.13	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*, . .	12.67	2.95	9.72	1:3.29	13.71	3.95	9.76	1:2.47	13.61	3.85	9.76	1:2.54	13.11	4.20	8.91	1:2.12	13.26	4.10	9.16	1:2.23	13.61	4.25	9.36	1:2.20
Series I. *b*, . .	13.33	4.00	9.33	1:2.33	14.18	4.85	9.33	1:1.92	13.12	4.20	8.92	1:2.12	13.41	4.48	8.93	1:1.99	13.59	4.55	9.04	1:1.99	14.11	4.50	9.61	1:2.14
Average, .	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Series II. *a*, . .	13.73	4.60	9.13	1:1.98	14.29	5.20	9.09	1:1.75	13.65	4.80	8.85	1:1.84	13.47	5.20	8.27	1:1.59	13.72	4.90	8.82	1:1.80	13.75	4.40	9.35	1:2.13
Series II. *a*, . .	13.42	4.42	9.00	1:2.04	14.12	4.95	9.17	1:1.85	13.46	4.80	8.66	1:1.80	13.43	4.80	8.63	1:1.80	13.76	4.95	8.81	1:1.78	14.71	4.70	10.01	1:2.13
Average, .	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*, . .	12.91	4.20	8.71	1:2.07	13.93	5.00	8.93	1:1.79	13.50	4.80	8.70	1:1.81	13.29	4.50	8.79	1:1.95	13.63	4.30	9.33	1:2.17	14.16	4.30	9.86	1:2.29
Series II. *b*, . .	13.50	4.30	9.20	1:2.14	14.65	5.30	9.35	1:1.76	13.57	4.60	8.97	1:1.95	12.62	4.20	8.42	1:2.00	13.46	4.40	9.06	1:2.06	14.27	4.20	10.07	1:2.40
Average, .	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Series III. *a*, .	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05	*13.26	4.60	8.66	1:1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*, .	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14

* Hattie, new cow.

TABLE IV.

Summary of Averages.

	Digestible Protein Fed (Pounds).	NETTIE.				MARY.				GEM.			
		Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	2.60	13.10	4.18	8.92	1:2.13	14.12	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84
Series I. *b*,	1.30	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32
Per cent. increase *a* over *b*,	-	+0.77	+20.11	—6.30	-	+1.20	+1.60	—5.44	-	—0.45	+16.38	—7.71	-
Series II. *a*,	2.55	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83
Series II. *b*,	2.24	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88
Per cent. increase *a* over *b*,	-	+2.80	+6.12	+1.23	-	—0.56	—1.36	—0.11	-	+0.15	+2.08	—0.90	-
Series III. *a*,	2.91	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05
Series III. *b*,	3.76	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11
Per cent. increase *b* over *a*,	-	—1.19	—7.95	+2.09	-	—0.77	+4.17	—3.33	-	—0.45	—2.33	+0.45	-

TABLE IV. — *Concluded.*

Summary of Averages — Concluded.

	SARAH.				NORA.				NELLIE.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*,	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Per cent. increase *a* over *b*,	+3.92	+6.45	+2.69	-	+2.61	+4.39	+1.76	-	+1.23	−2.29	+3.90	-
Series II. *a*,	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*,	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Per cent. increase *a* over *b*,	+3.77	+14.94	−1.89	-	+1.42	+11.76	−4.24	-	−0.07	+7.06	−2.91	-
Series III. *a*,	13.26	4.60	8.66	1: 1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*,	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14
Per cent. increase *b* over *a*,	+4.83	+3.26	+6.40	-	−1.09	+2.38	−2.61	-	+0.47	+9.30	−3.17	-

One cannot fail to note the variations in the composition of the milk obtained in the different series. The percentage increase or decrease in the per cent. of total solids is relatively small, being in most cases from 5 to 3 per cent. The percentage variations in the per cent. of fat, on the other hand, are much wider, in some cases as high as 16 per cent. or more being noted. With some of the cows, in cases where more protein was fed, the percentage of solids not fat shows a steady decrease, the fat, on the other hand, increasing even more, showing that the solids not fat were somewhat depressed at the expense of the fat. With other cows this variation in solids not fat was very slight.

Series I. a and b.

In Series I. *b*, when but 1.30 pounds of digestible protein were fed in the daily ration, the amount of fat in the milk is noticeably lower than in Series I. *a*, when double the amount of protein was consumed daily. The percentage increase in the per cent. of the fat in Series I. *a* is also high, varying from 4 to 20 in case of the first five cows.

The total solids were also increased in *a*, but to a much less degree.

The solids not fat showed a percentage of decrease in case of the first three cows of some 6 per cent., and with the last three a slight increase appeared. The ratio of fat to solids not fat should by no means pass unnoticed. In case of the first five cows, in *a* it was as 1 : 1.95, while in *b* as 1 : 2.36.

The cows also differed in what may be termed their susceptibility to the influence of the different fodder rations. The percentage of fat increase in the milk in case of cows Sarah and Nora was not so great as in case of the first three cows; while in case of Nellie the extreme food changes seemed to have had a comparatively small influence on the composition of the milk. The animal appeared, however, to feel more than any of the other cows the bad effect of the improperly combined ration *b*. Her whole general appearance told of a non-suitable food supply. This cow illustrates quite clearly the fact that the composition of the milk of different cows can be differently affected by the same food combinations. Although she gave every appearance of receiving improper nourishment, she still maintained the quality of her milk. It is to be noticed that the milk of the last three cows appeared to be less affected than that of the first three. This might in a measure at least be due to other than food influences, for the two lots of cows received the same rations at different dates. The temperature of the stable showed no wide variations during either *a* or *b*.

Series II. a and b.

Here the differences are not so marked. Nettie, Sarah, Nora and Nellie show, however, a higher percentage of fat in case of ration *a*, when more protein and fat were fed. The total solids of Nettie, Sarah and Nora are also higher, but the percentage increase is not nearly as marked as in case of the fat. The solids not fat on the whole appear to have been little affected. The ratio of fat to solids not fat for the six cows fed on ration *a* is as 1 : 1.88 ; while ration *b* was fed the ratio is as 1 : 2.03.

Series III. a and b.

The ratio of fat to solids not fat in *a* is as 1 : 2.10 and in *b* as 1 : 2.07, showing practically identical results. The variations in the per cents. of both the solids and the fat are in nearly every case quite small.

In order to get a better illustration of the effect of the food or protein upon the fat of the milk, the following table is presented, showing the fat percentage on the basis of 13 per cent. of solid matter in the milk: —

TABLE V.

Showing Fat Percentages on Basis of 13 Per Cent. Total Solids.

	Protein fed (Pounds).	Nettie. (Per Cent. Fat.)	Mary. (Per Cent. Fat.)	Gem. (Per Cent. Fat.)	Sarah. (Per Cent. Fat.)	Nora. (Per Cent. Fat.)	Nellie. (Per Cent. Fat.)
Series I. *a*, ...	2.60	4.15	4.69	4.58	4.36	4.27	3.93
Series I. *b*, ...	1.30	3.48	4.10	3.92	4.25	4.11	4.11
Percentage increase *a* over *b*, .	-	+13.51	+14.40	+16.84	+2.59	+3.89	—4.38
Series II. *a*, ...	2.55	4.32	4.65	4.60	4.83	4.66	4.16
Series II. *b*, ...	2.24	4.18	4.68	4.51	4.36	4.18	3.88
Percentage increase *a* over *b*, .	-	+3.35	±	+2.00	+10.78	+11.48	+7.22
Series III. *a*, ...	2.91	4.25	4.42	4.26	4.51	3.96	3.81
Series III. *b*, ...	3.76	3.98	4.64	4.18	4.44	4.11	4.14
Percentage increase *b* over *a*, .	-	—6.35	+4.97	—1.88	—1.55	+3.78	+8.66

The same remarks that were made in relation to the previous table apply with equal force here. In Series I. the fat percentage is distinctly higher in *a* than in *b*, the per cent. increase in percentage of fat in case of five cows being from 2.5 to nearly 17 per cent. In Series II. *a*, when 2.55 pounds of protein were fed, the per cent. increase in the percentage of fat is from 2 to 11.50 per cent. above that obtained in *b*, when 2.24 pounds of protein were consumed. In Series III. no distinctly noticeable effect of the food is to be seen on the percentage of fat in the milk.

In Series I., II. and III. *a*, when from 2.55 to 2.91 pounds of digestible protein were fed daily, the percentage of fat in the milk of each of the cows appears to be very even. Two cows show rather wide variations at times, but this can be accounted for only from the condition of the cow, and not from the food influence.

It is well known that the fat content of the milk will vary from time to time when the same fodder ration is fed.

TABLE VI.

Showing Average Results from Six Cows.

	Average Weight of Cows (Pounds).	AVERAGE DIGESTIBLE NUTRIENTS CONSUMED DAILY ON BASIS OF 1,000 POUNDS LIVE WEIGHT.*		Nutritive Ratio.	Total Amount of Milk produced on Basis 13 Per Cent. Solids (Pounds).	Total Solid Matter in Milk (Pounds).	Total Butter Fat in Milk (Pounds).	Average Per Cent. Total Solids in Milk.	Average Per Cent. Solids not Fat in Milk with 13 Per Cent. Solids.	Average Per Cent. Butter Fat in Milk with 13 Per Cent. Solids.
		Protein (Pounds).	Total Organic Matter (Pounds).							
Series I. *a*,	878	3.00	15.27	1:4.8	1,897.7	246.7	82.20	13.70	8.63	4.33
Series I. *b*,	867	1.50	15.27	1:10.0	1,685.3	219.25	67.66	13.47	9.01	3.99
Percentage increase *a* over *b*,	-	-	-	-	+12.6	+12.52	+21.49	+1.71	−4.10	+8.52
Series II. *a*,	871	2.93	15.65	1:4.8	1,731.3	225.0	78.44	13.80	8.47	4.53
Series II. *b*,	873	2.57	15.87	1:5.8	1,634.5	212.7	70.30	13.63	8.70	4.30
Percentage increase *a* over *b*,	-	-	-	-	+5.92	+5.78	+11.58	+1.25	−2.67	+5.35
Series III. *a*,	874	3.34	16.32	1:4.4	1,075.2†	139.77	45.30	13.73	8.80	4.20
Series III. *b*,	862	4.32	16.03	1:3.06	1,194.8†	155.31	50.76	13.77	8.75	4.25
Percentage increase *b* over *a*,	-	-	-	-	+11.1	+11.12	+12.05	±	±	+1.19

* Calculated from 871 pounds average weight.

† Nine-day period.

The above table presents the average results obtained from the six cows in each of the three series. The average weight of the herd remained quite constant during the four months' trial, showing a slight decrease in Series I. *b*, when a small amount of protein was fed, and another slight decrease in Series III. *b*, when a very large amount of protein was consumed. The total amount of organic matter fed in each series is practically the same, and, so far as the total digestible nutrients are concerned, the animals can be said to have been well nourished.

Series I. a and b.

The table shows that, with the same amount of total organic matter consumed daily, only one-half the digestible protein (1.50 pounds) was fed in ration *b* that was consumed in ration *a*.

The milk production in *b* decreased 12.60 per cent. on the basis of 13 per cent. solid matter, the total solid matter 12.52 per cent. and the total fat 21.49 per cent. The percentage decrease in the composition of the milk in *b* was in case of the total solids but 1.71 per cent., while in case of fat it was 8.52 per cent. with milk containing 13 per cent. solids. In this Series *a* the average results show the solids not fat were decreased only 4.10 per cent. Attention has already been called to the fact that some cows in this series showed a percentage decrease in the percentage of solids not fat of from 5 to 7 per cent.

The figures would seem to indicate that the lack of protein caused a decrease in the total milk yield, and also a decrease, although not so much, in the composition of the milk itself, especially in the fat content.

Series II. a and b.

The same is true of this series as of the former one. The variation in the protein supply is not so great, the difference being in the substitution of 3 pounds of corn meal for 3 pounds of Buffalo gluten feed. Ration *a*, when more protein was fed, produced 5.92 per cent. more milk with 13 per cent. solids and 5.78 per cent. more solid matter. The amount of fat increased 11.58 per cent. with ration *a*.

A percentage increase of 1.23 per cent. in the per cent. of total solids was noted, and a percentage increase of 5.35 per cent. in the per cent. of total fat on the basis of 13 per cent. solids.

It is quite possible that the high percentage of fat in the Buffalo gluten feed might have been instrumental in causing part, at least, of the increase in the fat percentage of the milk.

Series III. a and b.

In this series the amount of protein fed was very high. The maximum increase in the fat percentage in the milk appears to have been reached, for 4.32 pounds of protein did not seem to cause any increase in either the total solids or fat of the milk. Neither is any increase in the fat percentage to be noted in this period above the other periods, when 3 pounds of digestible protein were fed, being an indication at least that, other things being equal, more than 3 pounds of digestible protein daily ceases to exert any influence on the increase of fat in the milk.*

The increase in the protein supply, however, caused apparently 11.10 per cent. increase in the total yield of milk.

CONCLUDING OBSERVATIONS.

This experiment has some weak points, but it is believed they are not of such a serious nature as to interfere with its general teaching.

For example, the temperature of the stable was not a constant one, not being artificially heated. Again, the cows were divided into two lots, and one lot produced rather more milk daily than the other, but the difference was not excessive.

The milk should have been sampled for four or five days at least in every seven, instead of but for three days.

In the last series different coarse fodders were used from those fed in the two previous ones. The last series was of too short duration, and the first two series might have been at least a week longer. The daily supply of protein in each of the series should have been rather more regular in quantity, thus, 1.50, 2.00, 2.50, 3.00, 3.50 pounds, etc. Some rations contained more fat than others, which should have been avoided, for one cannot with certainty say that this increase in the fat supply of the food did not have an influence in increasing the fat in the milk.

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* In this series cow Hattie was substituted for Sarah. This cow gave milk of essentially the same fat content as did Sarah; still, it is not strictly fair to compare one series with another, for this reason.

The writer would of course draw no *particular conclusion* from this one experiment as to the effect of food, or any one group of food constituents, upon the quality of the milk. The results are simply presented just as they were found, and show what the six cows did in this particular case.

The experiment certainly indicates that rations so put together as to contain 2.5 to 3.5 pounds of digestible protein can be fed with greater profit to the farmer than rations containing 2 pounds.

The milk was principally affected in the first series, when the change from 1.5 to 3 pounds of digestible protein was made. If the change had been more gradual, it is possible that but little change in the milk would have been noted. It would have been interesting to note what the effect would have been on the milk composition if at the end of the three series the ration containing but 1.5 pounds of digestible protein had again been fed.

This experiment coincides with many previous investigations, only in our case the cows seemed to have been more generally affected by the different rations than in case of Kühn's or Wolff's various experiments.

DETAILS OF THE EXPERIMENT. — DAILY FEEDING RECORDS.

Nettie.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.							
Series I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	46.11	21.06	2.59	1.14	9.87	13.60	1: 4.91	830-810
I. *b*, ...	4.50	-	-	-	4.50	-	4.00	43.04	19.99	1.32	0.70	11.43	13.45	1:10.00	820-835
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	46.96	21.61	2.60	1.10	10.12	13.82	1: 4.95	835-840
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	46.04	21.22	2.22	0.89	10.66	13.77	1: 5.81	810-827
III. *a*, ...	3.00	-	-	3.00	3.00	9.00	7.67	-	22.23	2.86	0.67	10.80	14.89	1: 4.36	827-820
III. *b*, ...	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	817-827

Mary.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	48.00	20.26	2.59	1.13	10.12	13.84	1: 5.0	963-960
I. *b*, ...	4.50	-	-	-	4.50	-	4.00	52.61	21.98	1.39	0.77	12.54	14.70	1:10.4	990-995
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	54.38	23.23	2.66	1.17	11.06	14.89	1: 5.25	992-982
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	54.91	23.15	2.30	0.95	11.97	15.22	1: 6.24	977-960
III. *a*, ...	3.00	-	-	3.00	3.00	9.00	7.44	-	22.04	2.86	0.67	10.80	14.89	1: 4.36	945-925
III. *b*, ...	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	925-940

DETAILS OF THE EXPERIMENT — *Concluded.*

Gem.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.							
Series I. *a*,*	3.00	3.00	-	3.00	-	-	4.00	42.11	20.22	2.56	1.05	9.23	12.83	1:4.64	1037-1024
I. *b*,	4.50	-	-	-	4.50	-	4.00	43.30	20.04	1.31	0.67	11.22	13.20	1:9.84	1040-1030
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	41.39	20.40	2.56	1.06	9.50	13.12	1:4.75	1020-1027
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	42.09	20.36	2.18	0.85	10.10	13.13	1:5.61	995-1007
III. *a*,	3.00	-	-	3.00	3.00	9.00	6.60	-	21.36	2.81	0.66	9.92	13.39	1:4.12	1002-972
III. *b*,	-	3.00	3.00	3.00	-	14.00	1.67	-	21.87	3.82	0.90	9.53	14.25	1:3.08	975-1005

Sarah.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *b*,	4.50	-	-	-	4.50	-	4.00	33.89	17.96	1.22	0.63	10.09	11.94	1:9.56	755-772
I. *a*,	3.00	3.00	-	3.00	-	-	4.00	35.09	18.81	2.53	1.04	8.70	12.27	1:4.46	805-810
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	39.00	19.72	2.21	0.86	10.05	13.12	1:5.52	820-815
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	31.14	18.14	2.44	1.02	8.07	11.53	1·4.35	790-770
III. *b*,†	-	3.00	3.00	3.00	-	9.00	5.67	-	20.77	3.68	0.88	8.72	13.28	1:2.94	905-865
III. *a*,	3.00	-	-	3.00	3.00	14.00	2.11	-	22.05	2.97	0.69	10.17	14.03	1:4.00	863-885

Nora.

Series I. *b*, ...	4.50	-	-	-	4.50	-	4.00	44.36	20.14	1.31	0.71	11.39	13.41	1:10.00	813-800
I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	45.41	20.96	2.60	1.12	9.95	13.67	1: 4.09	825-845
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	49.29	21.96	2.29	0.93	11.28	14.50	1: 5.94	825-825
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	39.07	19.86	2.51	1.04	9.26	11.86	1: 4.73	812-825
III. *b*, ...	-	3.00	3.00	3.00	-	9.00	5.89	-	20.95	3.68	0.88	8.72	13.28	1: 2.94	805-785
III. *a*, ...	3.00	-	-	3.00	3.00	14.00	1.89	-	21.87	2.97	0.69	10.17	14.03	1: 4.00	840-850

Nellie.

Series I. *b*, ...	4.50	-	-	-	4.50	-	4.00	43.80	20.02	1.30	0.68	11.24	13.22	1:9.96	805-750
I. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	45.66	21.01	2.60	1.09	9.88	13.57	1:4.84	815-812
II. *b*, ...	3.00	-	-	3.00	3.00	-	4.00	47.14	21.49	2.26	0.91	10.89	13.16	1:5.82	815-805
II. *a*, ...	3.00	3.00	-	3.00	-	-	4.00	44.86	21.13	2.55	1.07	9.82	13.44	1:4.90	775-785
III. *b*, ...	-	3.00	3.00	3.00	-	9.00	6.08	-	21.11	3.68	0.88	8.72	13.28	1:2.94	757-732
III. *a*, ...	3.00	-	-	3.00	3.00	14.00	2.03	-	21.98	2.97	0.69	10.17	14.03	1:4.00	766-792

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* Period only eight days.

† Hattie, new cow.

TOTAL AMOUNTS OF FEEDS FED AND TOTAL COST OF FEED PER QUART OF MILK.

Nettie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *a*, ...	161.63	11.54	42.00	42.00	–	42.00	–	–	56.00	645.54	$2 29	1.42
I. *b*, ...	135.12	9.65	63.00	–	–	–	63.00	–	56.00	602.56	2 09	1.55
II. *a*, ...	148.60	10.61	42.00	42.00	–	42.00	–	–	56.00	637.44	2 28	1.53
II. *b*, ...	132.33	9.45	42.00	–	–	42.00	42.00	–	56.00	644.56	2 29	1.73
III. *a*, ...	75.35	8.37	27.00	–	–	27.00	27.00	81.00	69.03	–	1 64	2.18
III. *b*, ...	93.26	10.36	–	27.00	27.00	27.00	–	126.00	21.96	–	2 03	2.07

Mary.

Series I. *a*, ...	160.00	11.16	42.00	42.00	–	42.00	–	–	56.00	592.06	$2 22	1.39
I. *b*, ...	136.51	9.75	63.00	–	–	–	63.00	–	56.00	736.54	2 26	1.65
II. *a*, ...	143.02	10.21	42.00	42.00	–	42.00	–	–	56.00	761.32	2 44	1.70
II. *b*, ...	115.51	8.26	42.00	–	–	42.00	42.00	–	56.00	768.74	2 44	2.12
III. *a*, ...	61.81	6.87	27.00	–	–	27.00	27.00	81.00	66.96	–	1 64	2.65
III. *b*, ...	80.47	8.94	–	27.00	27.00	27.00	–	126.00	21.96	–	2 03	2.52

Gem.

Series I. *a*,*	75.81	9.48	24.00	24.00	-	24.00	-	-	32.00	336.88	$1 27	1.67
I. *b*, ...	117.67	8.40	63.00	-	-	-	63.00	-	56.00	606.20	2 09	1.78
II. *a*, ...	130.47	9.32	42.00	42.00	-	42.00	-	-	56.00	579.46	2 21	1.69
II. *b*, ...	119.53	8.54	42.00	-	-	42.00	42.00	-	56.00	589.26	2 22	1.02
III. *a*, ...	67.21	7.47	27.00	-	-	27.00	27.00	81.00	59.49	-	1 62	2.41
III. *b*, ...	83.02	9.22	-	27.00	27.00	27.00	-	126.00	15.03	-	1 93	2.32

Sarah.

Series I. *b*, ...	116.51	8.32	63.00	-	-	-	63.00	-	56.00	474.46	$1 93	1.66
I. *a*, ...	122.56	8.75	42.00	42.00	-	42.00	-	-	56.00	491.26	2 10	1.71
II. *b*, ...	111.16	7.94	42.00	-	-	42.00	42.00	-	56.00	546.00	2 17	1.95
II. *a*, ...	100.93	7.21	42.00	42.00	-	42.00	-	-	56.00	435.96	2 03	2.01
III. *b*,†	119.58	13.28	-	27.00	27.00	27.00	-	81.00	51.03	-	1 68	1.40
III. *a*, ...	123.72	13.75	27.00	-	-	27.00	27.00	126.00	18.99	-	1 86	1.50

Nora.

Series I. *b*, ...	101.63	7.26	63.00	-	-	-	63.00	-	56.00	621.04	$2 11	2.08
I. *a*, ...	109.30	7.81	42.00	42.00	-	42.00	-	-	56.00	635.74	2 28	2.08
II. *b*, ...	102.09	7.29	42.00	-	-	42.00	42.00	-	56.00	690.06	2 35	2.30
II. *a*, ...	98.60	7.04	42.00	42.00	-	42.00	-	-	56.00	546.98	2 16	2.20
III. *b*, ...	66.05	7.34	-	27.00	27.00	27.00	-	81.00	53.01	-	1 69	2.55
III. *a*, ...	65.12	7.24	27.00	-	-	27.00	27.00	126.00	17.01	-	1 85	2.85

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* Period only eight days.

† Hattie, new cow.

TOTAL AMOUNTS OF FEEDS FED AND TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

Nellie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *b*, ...	149.07	10.65	63.00	–	–	–	63.00	–	56.00	613.20	$2 10	1.41
I. *a*, ...	151.40	10.81	42.00	42.00	–	42.00	–	–	56.00	639.24	2 28	1.51
II. *b*, ...	144.42	10.32	42.00	–	–	42.00	42.00	–	56.00	659.96	2 31	1.60
II. *a*, ...	136.98	9.32	42.00	42.00	–	42.00	–	–	56.00	628.04	2 27	1.66
III. *b*, ...	82.56	9.17	–	27.00	27.00	27.00	–	81.00	54.72	–	1 69	2.05
III. *a*, ...	80.23	8.92	27.00	–	–	27.00	27.00	126.00	18.27	–	1 85	2.31

*Average Analyses of the Various Articles of Fodder.**

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Dry Matter.								
Crude ash, . . .	7.01	0.94	0.14	7.31	1.29	7.62	7.14	4.53
" cellulose, . .	11.17	8.18	1.73	6.14	1.98	26.09	33.38	33.30
" fat, . . .	5.89	14.27	4.60	10.63	4.90	3.28	1.59	4.28
" protein, . .	17.92	23.45	37.09	48.64	11.07	14.42	9.91	6.31
Nitrogen-free extract .	58.01	53.16	56.44	27.28	80.76	48.59	47.98	51.58
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Several lots of some of the different grains were purchased, but they varied so little in composition that only an average analysis is here presented.

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Crude cellulose, . .	25	43	–	–	77	64	67	63
" fat, . . .	72	81	88	97	85	46	52	80
" protein, . .	78	85	87	88	72	62	52	53
Nitrogen-free extract, .	68	81	91	64	94	66	64	68

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Moisture, ...	13.00	9.00	9.00	8.00	16.00	12.00	17.00	79.00
Nitrogen, ...	2.49	3.42	5.38	7.16	1.49	2.03	1.32	0.21
Phosphoric acid, . . .	2.46	0.35	0.42	2.37	0.70	0.62	0.05	0.03
Potassium oxide, . . .	1.58	0.06	0.07	1.70	0.40	1.83	1.82	0.41
Valuation per 2,000 pounds, .	$11 51	$10 67	$16 65	$25 55	$5 57	$8 54	$5 83	$1 05
Manurial value obtainable, .	9 21	8 54	13 32	20 44	4 46	6 83	4 66	0 84

Dry-matter Determinations of Foods Fed.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Series I. *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6,	85.68	91.80	-	93.20	82.51	-	82.85	20.87
Series I. *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6,	87.35	91.80	-	93.20	83.59	-	82.85	20.87
Series II. *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6,	86.80	89.59	-	92.38	84.14	-	82.85	21.80
Series II. *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6,	86.80	89.50	-	91.46	83.94	-	82.85	21.80
Series III. *a.* Cows 1, 2, 3, *b.* Cows 4, 5, 6,	87.12	89.50	90.28	91.90	86.30	88.00	82.85	-
Series III. *b.* Cows 1, 2, 3, *a.* Cows 4, 5, 6,	87.60	89.00	91.00	92.80	86.30	88.00	82.00	-

Dry Matter in Refuse left in Mangers.

FEEDING PERIODS.	Nettie.	Mary.	Gem.	Sarah.	Nora.	Nellie.
Series I. *a*, ...	23.00	21.00	50.00	21.00	22.00	28.00
Series I. *b*, ...	19.00	19.00	38.00	22.00	21.00	23.00
Series II. *a*, ...	34.00	25.00	30.00	25.00	24.00	30.00
Series II. *b*, ...	31.00	21.00	39.00	21.00	26.00	32.00
Series III. *a*, ...	77.00	79.00	78.00	88.00*	80.00	81.00
Series III. *b*, ...	85.00	85.00	86.00	68.00*	72.00	72.00

* Hattie, new cow.

Average Composition of the Waste (Dry Matter).

	Per Cent.
Crude ash, ...	5.10
" cellulose, ...	39.00
" fat, ...	1.70
" protein, ...	6.70
Nitrogen-free extract, ...	47.50
	100.00

The waste in all of the periods was of the same character, viz., the coarser portion of the corn stalks from the corn stover and ensilage. The amount left by each of the cows in each series was carefully sampled and tested. It proved to be so identical in composition that one average analysis is given, which it is believed will fairly represent the composition of the whole.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
Corn meal,	19 00
Rowen,	15 00
Corn stover,	5 00
Corn ensilage,	2 50

Temperature of Stable (Fahr.).

DATE.	Temperature.	DATE.	Temperature.
Series I., Jan. 16,	45	Series II., March 8,	47
17,	42	9,	50
18,	38	10,	55
19,	44	11,	54
20,	42	12,	52
21,	41	19,	62
22,	46	20,	55
23,	42	21,	50
24,	45	22,	53
25,	42	23,	48
26,	37	24,	45
27,	40	25,	49
28,	39	26,	42
29,	35	27,	42
Feb. 6,	35	28,	41
7,	38	29,	45
8,	46	30,	45
9,	45	31,	47
10,	46	April 1,	47
11,	43	Series III., April 8,	45
12,	36	9,	44
13,	34	10,	46
14,	34	11,	45
15,	37	12,	44
16,	34	13,	48
17,	30	14,	52
18,	43	15,	56
19,	42	16,	55
Series II., Feb. 27,	40	22,	59
28,	41	23,	59
March 1,	45	24,	58
2,	47	25,	58
3,	49	26,	60
4,	49	27,	65
5,	51	28,	64
6,	57	29,	61
7,	56	30,	63

3. CREAMERY RECORD OF THE STATION.

1893–94.

The cost of feed consumed is based on the market prices stated below. The valuation of the whole milk is taken at three cents per quart.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	20 00
Peoria gluten feed,	20 00
King gluten meal,	25 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
New-process linseed meal,	28 00
Corn meal,	19 00
Corn and cob meal,	18 00
Mixed grains,	22 00
Hay,	15 00
Rowen,	15 00
Green fodder corn,	2 50
Corn stover,	5 00
Corn ensilage,	2 50
Soja-bean hay,	15 00
Vetch and oats (dry),	15 00
Barley straw,	10 00
Green rye,	2 50
Vetch and oats (green),	2 50
Hungarian grass (green),	2 50
Buckwheat (green),	2 50
Mixed green crops,	2 50
Potatoes,	2 50

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Moisture.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per 2,000 Pounds.
Wheat bran,	11.00	2.48	2.85	1.63	$11 92
Buffalo gluten feed,	8.80	3.78	0.05	0.10	11 49
Peoria gluten feed,	8.50	3.50	0.05	0.10	10 65
King gluten meal,	7.80	5.69	0.69	0.08	17 84
Chicago gluten meal,	8.50	5.10	0.42	0.05	15 77
Cotton-seed meal,	8.00	6.47	2.75	1.98	24 14
New-process linseed meal,	11.00	5.83	1.95	1.08	20 52
Corn meal,	16.00	1.49	0.70	0.40	5 57
Corn and cob meal,	23.00	1.23	0.70	0.40	4 79
Mixed grains,	12.00	3.50	1.30	1.00	12 80
Hay,	15.00	1.47	0.27	1.50	6 18
Rowen,	12.00	1.72	0.47	1.63	7 26
Green fodder corn,	80.00	0.19	0.15	0.33	1 05
Corn stover,	17.00	1.32	0.05	1.82	5 83
Corn ensilage,	79.00	0.21	0.03	0.41	1 05
Soja-bean hay,	16.00	2.00	0.50	1.24	7 74
Vetch and oats (dry),	17.00	1.81	0.50	1.24	7 17
Barley straw,	13.00	0.86	0.12	2.60	5 30
Green rye,	72.00	0.30	0.12	0.64	1 66
Vetch and oats (green),	75.00	0.44	0.13	0.42	1 87
Hungarian grass (partly dry),	60.00	0.60	0.24	0.80	2 84
Buckwheat (green),	85.00	0.44	0.09	0.54	1 95
Mixed green crops,	80.00	0.43	0.15	0.35	1 79
Potatoes,	80.00	0.33	0.13	0.59	1 71

Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C.,	72.00–74.00
Nitrogen (15 cents per pound),	0.54
Phosphoric acid (5 cents per pound),	0.17
Potassium oxide (5 cents per pound),	0.12

The monthly value placed upon the cream is the price paid for the same by the local creamery. The financial statement is based on the local cost of feed, and does not take into consideration interest on investment or cost of labor involved.

The results here presented are stated under the following separate headings : —

1. Statement of articles of fodder used.
2. Value of cream at creamery basis of valuation.
3. Cost of skim-milk on the basis of three cents per quart for whole milk.
4. Analyses of milk and cream.
5. What the creamery records show.

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1893 (POUNDS).

1893.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Serradella and Hungarian Grass Ensilage.	Soja-bean Hay.	Peas and Oats (Dry).	Vetch and Oats (Dry).	Barley Straw.	Vetch and Oats (Green).	Buckwheat (Green).	Vetch (Green).
January, .	489.00	489.00	442.00	-	1,080.00	-	-	742.50	2,968.50	-	-	-	-	-	-	-	-	-
February, .	504.00	504.00	491.00	-	798.00	-	-	-	7,084.00	-	-	-	-	-	-	-	-	-
March, .	516.00	516.00	507.00	-	721.00	-	-	-	9,103.00	-	-	-	-	-	-	-	-	-
April, .	507.00	507.00	426.00	-	781.00	-	-	-	2,530.00	1,370.00	4,751.00	-	-	-	-	-	-	-
May, . .	555.00	555.00	555.00	-	753.00	-	-	-	-	9,233.00	-	-	-	448.00	-	-	-	-
June, .	540.00	540.00	540.00	-	-	942.00	-	-	-	-	-	-	1,564.00	184.00	-	-	-	-
July, . .	558.00	558.00	409.50	130.50	-	1,820.00	-	-	-	-	-	-	-	-	-	3,880.00	-	-
August, .	558.00	558.00	-	558.00	-	2,726.00	-	-	-	-	-	-	-	-	-	-	633.00	252.00
September,	531.00	531.00	-	519.00	264.00	636.00	948.00		-	-	-	-	-	-	-	-	-	-
October, .	558.00	558.00	-	558.00	1,757.00	-	7,818.00	-	-	-	-	-	-	-	-	-	-	-
November,	540.00	540.00	-	540.00	-	-	-	-	-	-	-	-	129.00	2,877.00	-	-	-	-
December,	551.00	551.00	-	539.00	72.00	-	-	-	-	-	-	2,139.00	-	49.00	971.00	-	-	-

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1894 (POUNDS).

1894.	Wheat Bran.	Buffalo Gluten Feed.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Cotton-seed Meal.	New-process Linseed Meal.	Corn Meal.	Corn and Cob Meal.	Mixed Grains.	Hay.	Rowen.
January,	679.00	292.00	-	-	-	236.00	52.00	368.00	-	-	162.00	-
February,	590.00	255.00	-	-	-	324.00	-	344.00	-	-	-	-
March,	558.00	279.00	-	-	-	558.00	-	279.00	-	-	-	-
April,	279.00	270.00	-	-	261.00	540.00	-	270.00	-	-	-	1,986.00
May,	765.00	-	-	322.00	317.00	126.00	-	126.00	-	-	-	1,452.00
June,	671.00	-	-	338.00	333.00	-	-	-	-	248.00	-	2,447.00
July,	233.00	233.00	-	233.00	-	-	-	-	-	864.00	-	1,305.00
August,	803.00	293.00	-	390.00	-	-	-	-	341.00	-	-	2,325.00
September,	732.00	-	416.00	227.00	-	-	-	-	36.00	-	-	690.00
October,	899.00	-	472.00	55.00	6.00	-	-	-	15.00	-	-	-

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1894 (POUNDS) — *Concluded.*

1894.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Soja-bean Hay.	Vetch and Oats (Dry).	Barley Straw.	Green Rye.	Vetch and Oats (Green).	Hungarian Grass (Green).	Buckwheat (Green).	Mixed Green Crops.	Potatoes.
January,	-	572.00	7,840.00	288.00	-	40.00	-	-	-	-	-	-
February,	-	672.00	8,610.00	-	-	-	-	-	-	-	-	-
March,	-	744.00	9,085.00	-	-	-	-	-	-	-	-	-
April,	-	1,170.00	295.00	-	-	-	-	-	-	-	-	-
May,	-	294.00	-	-	-	-	4,801.00	-	-	-	-	-
June,	-	-	-	-	-	-	-	1,525.00	-	-	580.00	-
July,	-	-	-	-	-	-	-	5,350.00	-	1,100.00	1,310.00	-
August,	3,630.00	-	-	-	-	-	-	-	-	-	-	-
September,	6,255.00	-	-	-	-	-	-	-	1,270.00	-	-	520.00
October,	-	1,410.00	-	390.00	288.00	-	-	-	3,186.00	-	-	1,920.00

2. VALUE OF CREAM AT CREAMERY BASIS OF VALUATION.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1893.					
January,	$30 41	$22 81	$0 67	$12 83	$41 69
February,	32 44	20 05	80	17 20	49 39
March,	35 07	24 91	91	16 05	56 32
April,	33 59	25 42	70	13 95	41 24
May,	40 29	27 98	70	18 61	38 95
June,	38 27	28 48	62	16 11	32 80
July,	36 81	26 34	61	16 35	31 57
August,	40 31	26 74	60	19 52	31 32
September,	33 61	18 99	55	18 97	32 88
October,	41 57	28 68	61	19 24	36 32
November,	40 10	30 93	55	15 91	32 72
December,	39 56	26 75	51	18 67	30 76
Averages,	$36 84	$25 67	$0 65	$16 95	$38 00
1894.					
January,	$31 43	$17 65	$0 70	$18 01	$36 97
February,	28 08	16 33	60	15 62	31 35
March,	31 21	19 39	66	16 36	33 47
April,	33 90	23 31	61	15 86	28 56
May,	29 72	21 91	64	12 83	27 55
June,	38 47	22 06	59	21 41	24 92
July,	36 44	22 32	50	19 08	22 25
August,	40 49	21 12	62	24 21	30 28
September,	29 42	16 71	47	16 52	25 29
October,	29 16	21 29	46	12 59	25 92
Averages,	$32 83	$20 21	$0 59	$17 25	$28 66

3. COST OF SKIM-MILK ON THE BASIS OF THREE CENTS PER QUART FOR WHOLE MILK.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1893.									
January, .	1,625.2	981.0	288.5	1,336.5	4.25	2.57	$41 69	0.53	$7 06
February, .	2,007.4	1,176.0	345.9	1,651.5	4.20	2.46	49 39	0.66	10 83
March, . .	2,332.5	1,341.0	394.4	1,938.1	4.20	2.41	56 32	0.70	13 65
April, . .	2,008.7	1,031.0	303.2	1,705.5	4.00	2.05	41 24	1.11	19 02
May, . .	1,997.6	1,025.0	301.5	1,696.1	3.80	1.98	38 95	1.24	20 97
June, . .	1,668.6	911.0	267.9	1,400.7	3.60	1.96	32 80	1.23	17 25
July, . .	1,632.2	902.0	265.3	1,366.9	3.50	1.93	31 57	1.16	17 39
August, .	1,743.9	870.0	258.9	1,495.0	3.60	1.61	31 32	1.41	20 99
September, .	1,605.6	822.0	241.8	1,363.8	4.00	2.04	32 88	1.12	15 28
October, .	1,811.3	908.0	267.1	1,544.2	4.00	2.01	36 32	1.17	18 02
November, .	1,694.8	818.0	240.6	1,454.2	4.00	1.93	32 72	1.25	18 12
December, .	1,626.3	769.0	226.2	1,400.1	4.00	1.89	30 76	1.29	18 03
Averages, .	1,812.8	962.8	283.4	1,529.4	3.93	2.07	$38 00	1.07	$16 39
1894.									
January, .	1,879.5	973.0	286.2	1,593.3	3.80	1.97	$36 97	1.22	$19 42
February, .	1,569.3	836.0	253.8	1,315.5	3.75	2.00	31 35	1.20	15 73
March, . .	1,637.9	917.0	269.7	1,368.2	3.65	2.04	33 47	1.15	15 67
April, . .	1,639.2	850.0	250.0	1,389.2	3.36	1.74	28 56	1.48	20 62
May, . .	1,903.0	889.0	261.5	1,641.5	3.10	1.45	27 55	1.77	29 54
June, . .	1,905.1	817.0	240.3	1,664.8	3.05	1.31	24 92	1.94	32 23
July, . .	1,683.5	704.0	207.1	1,476.4	3.16	1.32	22 25	1.91	28 26
August, .	1,633.3	865.0	254.4	1,378.9	3.50	1.85	30 28	1.35	18 72
September, .	1,593.7	657.0	193.2	1,400.5	3.85	1.59	25 29	1.68	22 52
October, .	1,480.0	648.0	190.6	1,289.4	4.00	1.75	25 92	1.43	18 48
Averages, .	1,692.5	815.6	240.7	1,451.8	3.52	1.70	$28 66	1.51	$22 12

4. ANALYSES OF MILK AND CREAM.

The station herd consisted of six cows of various grades, purchased in the vicinity, and are fair representatives of the cows kept by average farmers of this section. Here follows the monthly average of the composition of the milk.

As some of the cows were replaced by others during the year, no particular conclusions can be drawn relative to the difference in the solids and fat percentages.

	Total Solids.	Fat.
January,	13.49	4.33
February,	13.65	4.17
March,	13.71	4.66
April,	13.76	4.47
May,	13.49	3.93
June,	13.36	4.12
July,	13.48	4.44
August,	–	–
September,	13.85	3.87*
October,	–	4.47

* Cows not in good condition; fat percentage noticeably affected.

Composition of Cream.

The station cream, obtained by the Cooley process, when properly treated and the skim-milk carefully drawn, contains about 18.50 per cent. of fat.

5. WHAT THE CREAMERY RECORD SHOWS.

1. The nutritive ratio of the feed varied in 1893 from 1 : 3.50 to 1 : 5.00, with an average of 1 : 4.38; in 1894 from 1 : 4.50 to 1 : 5.50, with an average of 1 : 5.00.

2. The average monthly percentage of fat in the milk varied in 1893 from 4.37 to 4.84, with an average of 4.59; in 1894 from 3.87 to 4.47, with an average of 4.27.

3. The average monthly percentage of total solids varied in 1893 from 13.64 to 14.01, with an average of 13.84; in 1894 from 13.36 to 13.85, with an average of 13.60.

4. The relation of fat to solids not fat in 1893 was 1 : 2.02, while in 1894 it was 1 : 2.18.

5. The total cost of feed for one quart of cream amounted in 1893 to 13.00 cents and in 1894 to 13.64 cents.

6. The net cost of feed for one quart of cream amounted in 1893 to 5.98 cents and in 1894 to 7.17 cents.

7. The value received for one space of cream varied in 1893 from 3.50 to 4.25 cents, with an average of 3.93 cents; in 1894 from 3.10 to 4.00 cents, with an average of 3.52 cents, which amounted per quart (average) in 1893 to 13.36 cents, and in 1894 to 11.97 cents.

8. The number of quarts of milk required to produce one space of cream in 1893 was 1.88 and in 1894 2.08; or 6.39 quarts of whole milk to produce one quart of cream in 1893, and 7.07 quarts of whole milk to produce one quart of cream in 1894.

9. The net cost of feed per quart of cream averaged in 1893 5.98 cents and in 1894 7.17 cents. Received per quart of cream in 1893 13.36 cents and in 1894 11.97 cents, thereby securing a profit of 7.38 cents per quart in 1893 and 4.80 cents in 1894.

Our average statements for the current year apply in each case to only ten months, due to the fact that the financial settlement is made with our local creamery two months after the cream is furnished.

IV.

HAY SUBSTITUTES.

By J. B. Lindsey.

Vetch and Oats and Peas and Oats.

The many experiments made at this station have pointed out the costliness of English hay as a coarse fodder for milk production, and the substitution of other coarse fodders in its place. Among those fodders with which good success has been obtained may be mentioned vetch and oats and peas and oats. These fodders have given quite satisfactory results, both when fed green and when made into hay.

The results of two experiments may be cited. In one case rowen and hay of peas and oats were compared, and in another good English hay and hay of vetch and oats. The grain fed was constant in each case during the entire experiment.

I.

[Rowen *vs.* hay of peas and oats. Summer of 1893. Average results from four cows. Length of rowen period, 9 days; peas and oats period, 14 days.]

	Rowen.	Peas and Oats.
Average daily yield of milk, ...	9.33 qts.	9.30 qts.
Average cost per quart, ...	2.47 cts.	2.35 cts.

II.

[English hay *vs.* hay of vetch and oats. Autumn of 1894. Average results from six cows. Length of English hay period, 12 days; vetch and oats period, 34 days.]

	English Hay.	Vetch and Oats.
Average daily yield of milk, ...	10.22 qts.	9.43 qts.
Average cost of milk per quart, . . .	2.25 cts.	2.35 cts.

In case of I. the yield and cost of milk are practically identical, while in II. the hay has slightly the advantage. This is, however, largely offset when it is noted (see summary above) that the vetch and oats period was four times as long as the hay period; cows would naturally shrink somewhat in their yield during this time. The cows gained in flesh during the vetch and oats period.

Yield per Acre of Vetch and Oats.

We have succeeded in raising on an average about three tons of hay per acre. It begins to bloom between the 25th of June and the 10th of July, depending of course on the season. It can be fed as a green fodder for some ten days, and the remainder made into hay, or it can be cut directly. Several lots of seed can be sown some ten days apart in the spring, and green fodder thus secured for nearly a month. After cutting the vetch and oats the land can be ploughed and planted to a second fodder crop. We followed vetch and oats this year with Hungarian grass, and in spite of the extremely dry season succeeded in getting one ton per acre of Hungarian hay. Had there been a fair amount of rainfall, this yield would certainly have been doubled. By this method four tons of hay per acre of an equal value with good English hay were secured. The land was manured with ten tons of barn-yard manure in the spring, and received no other fertilizer during the season. In place of the manure six hundred pounds of ground bone with two hundred pounds of muriate of potash would have answered the same purpose.

Seed per Acre.

It has been found that four bushels of oats and fifty pounds of vetch are about the right quantities and proportion for one acre. Both seeds are sown at the same time, and harrowed in. In our case an Acme harrow was used.

Composition of English Hay and Vetch and Oats compared.

Dry Matter.	English Hay.	Vetch and Oats.
Crude ash,	6.58	10.65
" cellulose,	30.33	35.95
" fat,	3.48	2.61
" protein,	11.10	13.42
Nitrogen-free extract,	48.51	37.37
	100.00	100.00

Digestibility.

The percentages of digestibility of the different ingredients in each of the above hays are the results of actual estimations at this station.

Coefficients of Digestibility.

	English Hay.	Vetch and Oats.
Crude cellulose,	60	66
" fat,	49	19
" protein,	60	58
Nitrogen-free extract,	60	54

Pounds of Digestible Matter in 2,000 Pounds of the Perfectly Dry Hays.

English hay,	1,113
Vetch and oats,	1,043

It will thus be seen that the vetch and oats furnish very nearly as much digestible matter in a ton as an extra quality of hay. The digestible protein in the vetch and oats is fully one per cent. higher than in the hay.

The hay grown upon the station grounds is of extra quality, having a considerable sprinkling of clover, and showing at best two per cent. more protein than the average hay grown upon New England farms.

Vetch and oats has the advantage over peas and oats in that the vetch stands up much better, and can be easily cut with a mowing machine. To secure the best results, the crops should be cut when in early to middle bloom. If cut when in late bloom the oats will have developed a considerable amount of woody fibre, rendering them less palatable and digestible.

V.

THE BABCOCK vs. THE "SPACE" SYSTEM, AS A BASIS FOR PAYMENT IN MASSACHUSETTS CREAMERIES.

BY J. B. LINDSEY.

By the Babcock system is meant the weighing of each patron's daily cream, raised or separated by whatever process, taking a fair sample of it, with a suitable sampler, preserving the daily samples, and once in ten days to two weeks testing this average sample for the percentage of butter fat by means of the Babcock tester. The percentage of butter fat found, multiplied by the pounds of cream, gives the pounds of butter fat actually in the cream.

The directors of the creamery, having a certain sum of money to divide, and knowing the total number of pounds of butter fat collected, divide the former amount by the latter; the quotient resulting represents the *price per pound* to be paid for the butter fat. The value of a pound of butter fat for the month having been in this way determined, is multiplied by the pounds of butter fat furnished by the patron, and the product represents the money he is entitled to each month for his cream. By this method the value of the cream is based entirely upon its content of butter fat.

The space system is familiar to all. The milk in deep-setting cans is submerged in ice water, and after a certain time the number of spaces of cream on each can is read by means of a strip of graduated glass set in the side of the can. A "space" is a circular volume of cream, $\frac{19}{64}$ of an inch thick, and $8\frac{1}{2}$ inches in diameter. It is assumed by those who favor this system that a space of cream has comparatively the same value, no matter from what milk it is raised. A given quantity of poor milk may furnish fewer spaces than the same quantity of rich milk, it is argued, but the quality of the space would be equally as valuable for butter purposes.

The Babcock test as a basis for payment is used almost exclusively in the West. According to Professor Jordan,* the larger number of Maine creameries are using this system. In Vermont a very large portion of the milk and cream sold is paid for on the basis of butter fat it contains. In Connecticut the creameries are gradually adopting the Babcock system, and the writer has heard of several Massachusetts creameries employing it. Many inquiries have been made during the past year as to the comparative merits of the Babcock and the " space " systems, and the writer thought it advisable, therefore, to make an investigation, and to present the results obtained *as an object lesson* to those interested in this all-important branch of farm industry. Such an investigation had already been made by the Connecticut Experiment Station, and the results published in Bulletin 119. That station has recommended the Babcock system for general use in Connecticut creameries.

THE INVESTIGATION.

The Cream collected and tested for Butter Fat.

The writer personally accompanied the cream gatherers of a large creamery in this locality, and took as fair a sample as possible of the cream of one hundred and sixty-five different patrons, by means of a small glass rod run into the mixed cream after the milk had been drawn, care being taken to draw off the milk as thoroughly as possible in each case. The sample of cream was run into small numbered glass bottles, and tested for butter fat by the Babcock method on the same day. The weight of the cream was also noted, as well as the number of spaces, and the temperature of the water in the tank. The result of this inquiry is presented in Table I. : —

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* See report of Prof. W. H. Jordan's lecture before Connecticut farmers in "New England Homestead," Feb. 15, 1894.

TABLE I.

COLUMNS —								
1 Number of Patron.	2 Spaces of Cream.	3 Pounds of Cream.	4 Per Cent. of Fat in Cream.	5 Pounds of Fat in Cream.	6 Pounds of Fat in 100 Spaces of Cream.	7 Value of Cream at 3.05 Cents per Space.	8 Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	9 Payment by Babcock Test would give + or − than by Space System for 30 Days.
1	54	40.00	18.70	7.48	13.86	$1 65	$1 63	—$0 60
2	39	29.50	20.00	5.99	15.35	1 19	1 31	+3 60
3	20	15.00	17.10	2.56	12.80	61	56	—1 50
4	80	61.75	16.90	10.43	13.04	2 44	2 28	—4 80
5	8	6.25	20.00	1.25	15.62	24	27	+ 90
6	28	23.25	15.70	3.65	13.00	85	79	—1 80
7	34	24.25	21.60	5.23	15.41	1 04	1 14	+3 00
8	20	15.00	15.00	2.25	11.25	61	49	—3 60
9	29	22.00	18.10	3.98	13.74	88	87	— 30
10	10	8.50	18.00	1.53	15.30	30	33	+ 90
11	26	20.00	18.90	3.78	14.54	79	82	+ 90
12	57	43.25	17.20	7.44	13.05	1 74	1 62	—3 60
13	8	7.00	16.80	1.17	14.70	24	26	+ 60
14	24	19.00	21.40	4.06	16.98	73	89	+4 80
15	89	69.75	19.80	13.81	15.52	2 71	3 01	+9 00
16	77	57.50	17.80	10.23	13.29	2 35	2 23	—3 60
17	67	52.50	19.00	9.97	14.89	2 04	2 17	+3 90
18	47	37.50	16.70	6.26	13.32	1 43	1 37	—1 80
19	35	26.25	16.00	4.38	12.52	1 07	95	—3 60
20	108	82.75	19.00	15.72	14.56	3 29	3 43	+4 20
21	67	53.25	19.60	10.44	15.57	2 04	2 28	+7 20
22	51	38.00	20.20	7.68	15.04	1 56	1 68	+3 60
23	48	39.00	16.70	6.51	13.56	1 46	1 42	—1 20
24	68	47.75	19.70	9.40	13.82	2 07	2 05	— 60
25	28	23.00	20.20	4.65	16.60	85	1 01	+4 80
26	37	27.50	20.20	5.55	15.00	1 13	1 21	+2 40
27	42	33.00	18.50	6.10	14.54	1 28	1 33	+1 50
28	32	24.50	17.10	4.19	13.10	98	91	—2 10
29	14	14.25	14.60	2.08	14.80	43	45	+ 60
30	22	19.50	17.10	3.33	15.16	67	73	+1 80
31	15	11.25	18.50	2.08	13.87	46	45	— 30
32	29	22.75	17.10	3.89	13.42	88	85	— 90

TABLE I. — *Continued.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
33	24	19.25	18.2	3.53	14.71	$0 73	$0 77	+$1 20
34	25	21.25	19.3	4.10	16.40	76	89	+3 90
35	37	30.25	19.3	5.83	17.58	1 13	1 27	+4 20
36	182	126.75	17.2	21.80	12.00	5 55	4 76	—23 70
37	70	50.50	18.5	9.34	13.34	2 14	2 04	—3 00
38	48	35.50	19.1	6.84	14.24	1 46	1 49	+ 20
39	24	16.50	21.6	3.62	15.18	73	79	+1 80
40	28	19.00	18.6	3.53	12.62	85	76	—2 70
41	80	58.63	18.6	10.91	13.63	2 44	2 38	—1 80
42	42	34.00	11.0	3.74	8.90	1 28	82	—13 80
43	64	48.75	20.4	9.94	15.53	1 95	2 17	+6 60
44	35	27.40	19.8	5.46	15.61	1 07	1 19	+3 60
45	30	24.00	20.5	4.92	16.40	92	1 07	+4 50
46	18	15.50	17.2	2.66	15.41	55	58	+ 90
47	23	18.75	14.4	2.73	11.87	70	60	—3 00
48	41	32.25	18.3	5.90	14.39	1 25	1 29	+1 20
49	35	27.50	18.3	5.03	14.37	1 07	1 10	+ 90
50	84	66.75	18.3	12.21	14.54	2 56	2 66	+3 00
51	40	31.25	16.2	5.08	12.72	1 22	1 12	—3 00
52	24	22.00	17.3	3.80	15.83	73	83	+3 00
53	29	22.75	17.9	4.02	13.89	88	88	±
54	17	12.50	20.2	2.52	14.85	52	55	+ 90
55	20	15.50	20.4	3.16	15.81	61	69	+2 40
56	26	20.00	19.3	3.86	14.85	79	84	+1 50
57	17	14.75	15.3	2.26	13.27	52	49	— 90
58	24	18.00	20.0	3.60	15.00	73	78	+1 50
59	105	85.63	19.2	16.44	15.66	3 20	3 59	+11 70
60	136	97.50	21.5	20.96	15.41	4 15	4 57	+12 60
61	28	20.00	19.5	3.90	13.93	85	85	±
62	25	20.00	16.0	3.20	12.80	76	70	—1 80
63	14	10.75	18.3	1.97	14.00	43	43	±
64	57	43.50	18.2	7.91	13.88	1 74	1 73	— 30

TABLE I. — *Continued.*

COLUMNS —

1 Number of Patron.	2 Spaces of Cream.	3 Pounds of Cream.	4 Per Cent. of Fat in Cream.	5 Pounds of Fat in Cream.	6 Pounds of Fat in 100 Spaces of Cream.	7 Value of Cream at 3.05 Cents per Space.	8 Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	9 Payment by Babcock Test would give + or — than by Space System for 30 Days.
65	21	17.00	18.6	3.16	15.90	$0 64	$0 69	+$1 50
66	24	15.50	19.0	2.94	12.27	73	64	—2 70
67	29	21.50	18.4	3.95	13.64	88	86	— 60
68	17	13.25	17.2	2.27	13.41	52	50	— 60
69	20	15.00	19.1	2.86	14.32	61	62	+ 30
70	14	11.00	17.5	1.92	13.75	43	42	— 30
71	33	22.00	18.6	4.09	12.40	1 01	89	—3 60
72	22	13.50	21.0	2.83	12.89	67	62	—1 50
73	36	32.00	15.3	4.89	13.60	1 10	1 07	— 90
74	26	20.00	20.3	4.06	15.62	79	89	+3 00
75	21	17.00	16.5	2.80	13.35	64	61	— 90
76	47	33.50	20.9	7.00	14.90	1 43	1 53	+3 00
77	30	21.50	17.8	3.82	12.76	92	83	—2 70
78	38	26.50	19.4	5.14	13.53	1 16	1 12	—1 20
79	70	52.75	17.8	9.39	13.41	2 14	2 05	—2 70
80	27	20.50	17.3	3.54	13.13	82	77	—1 50
81	127	94.50	17.6	16.63	13.09	3 87	3 63	—7 20
82	31	21.25	20.2	4.29	13.85	95	94	— 30
83	9½	6.00	19.6	1.17	12.38	29	26	— 90
84	31	24.00	19.0	4.56	14.71	95	1 00	+1 50
85	7	5.00	19.2	0.96	13.71	21	21	±
86	17	12.50	22.0	2.75	16.18	52	60	+2 40
87	49	34.00	18.2	6.18	12.63	1 49	1 35	—4 20
88	22	16.80	17.7	2.97	13.51	67	65	— 60
89	39	32.00	15.0	4.80	12.31	1 19	1 05	—4 20
90	25	20.25	16.4	3.32	13.28	76	72	—1 20
91	28	22.50	16.7	3.75	13.42	85	82	— 90
92	29	25.00	18.8	4.70	16.21	88	1 03	+4 50
93	29	22.50	16.8	3.78	13.04	88	82	—1 80
94	46	37.75	17.7	6.68	14.52	1 40	1 46	+1 80
95	10	9.25	11.2	1.03	10.36	31	22	—2 70
96	58	46.00	16.9	7.77	13.40	1 77	1 70	—2 10

TABLE I. — *Continued.*

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
97	42	34.00	18.2	6.19	14.73	$1 28	$1 35	+$2 10
98	58	44.00	20.2	8.89	15.31	1 77	1 94	+5 10
99	28	23.75	18.0	4.27	15.27	85	93	+2 40
100	29	21.50	15.2	3.27	11.27	88	71	—5 10
101	21	18.63	16.4	3.05	14.55	64	67	+ 90
102	38	27.00	17.9	4.83	12.72	1 16	1 05	—3 30
103	9	8.75	15.6	1.36	15.17	27	30	+ 90
104	14	9.75	21.6	2.10	15 00	43	46	+ 90
105	25	16.80	20.2	3.33	13.32	76	73	— 90
106	15	10.25	17.1	1.75	11.68	46	38	—2 40
107	14	12.25	18.2	2.23	15.92	43	49	+1 80
108	56	41.50	18.3	7.59	13.56	1 71	1 66	—1 50
109	61	48.75	17.8	8.68	14.22	1 86	1 89	+ 90
110	14	12.50	17.2	2.15	15 36	43	47	+1 20
111	12	9.00	17.0	1.53	12.75	37	33	—1 20
112	13	10.75	16.4	1.76	13.56	40	38	— 60
113	13	9.75	16.7	1.62	12.52	40	35	—1 50
114	22	15.00	17.0	2.55	11.59	67	56	—2 70
115	12	10.25	16.4	1.68	14.00	37	37	±
116	21	14.50	20.9	3.13	14.93	64	68	+1 20
117	13	9.75	19.5	1.90	14.62	40	41	+ 30
118	19	14.50	21.4	3.10	16.33	58	68	+3 00
119	52	40.75	19.0	7.74	14.89	1 59	1 69	+3 00
120	51	38.00	18.4	6.99	13.71	1 56	1 53	— 90
121	48	35.50	18.8	6.67	13.90	1 46	1 45	— 30
122	51	42.25	17.9	7.56	14.82	1 56	1 66	+3 00
123	10	8.50	16.8	1.43	14.28	31	31	±
124	28	22.50	16.5	3.71	13.26	85	82	— 90
125	9	9.50	16.7	1.58	17.63	27	34	+2 10
126	38	26.50	20.1	5.33	14.02	1 16	1 16	±
127	29	23.00	17.0	3.91	13.48	88	85	— 90
128	38	25.50	17.2	4.39	11.54	1 16	96	—6 00

TABLE I. — *Continued.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
129	7	7.25	15.10	1.09	15.64	$0 21	$0 24	+$0 90
130	25	19.25	15.50	2.98	11.93	76	65	—3 30
131	15	11.00	17.50	1.92	12.83	46	42	—1 20
132	8	7.75	15.80	1.22	15.31	24	27	+ 90
133	11	9.00	15.00	1.35	12.27	34	29	—1 50
134	12	10.00	17.40	1.74	14.50	37	38	+ 30
135	10	8.50	14.10	1.19	11.98	31	26	—1 50
136	7	5.25	16.30	0.86	12.22	21	19	— 60
137	41	32.25	17.80	5.74	14.00	1 25	1 26	+ 30
138	10	8.25	17.60	1.45	14.52	31	32	+ 30
139	15	13.50	14.50	1.96	13.05	46	43	— 90
140	11	9.50	14.50	1.37	12.52	34	30	—1 20
141	13	10.25	16.20	1.66	12.77	40	36	—1 20
142	11	8.50	18.00	1.53	13.91	34	33	— 30
143	43	34.63	17.80	6.14	14.29	1 31	1 34	— 90
144	35	29.50	15.70	4.63	13.23	1 07	1 01	—1 80
145	54	41.50	19.60	8.13	15.04	1 65	1 78	+3 90
146	56	42.00	19.50	8.19	14.63	1 71	1 79	+2 40
147	18	14.00	17.50	2.45	13.61	55	53	— 60
148	24	19.75	17.80	3.51	14.23	73	77	+1 20
149	30	26.00	17.20	4.47	13.91	92	98	+1 80
150	26	19.50	18.10	3.53	13.58	79	77	— 60
151	35	26.75	19.60	5.24	14.98	1 07	1 14	+2 10
152	6	3.50	18.80	0.66	10.97	18	14	—1 20
153	36	26.00	18.00	4.68	13.00	1 10	1 02	—2 40
154	62	45.50	18.80	8.55	13.79	1 89	1 87	— 60
155	18	15.50	16.40	2.54	14.12	55	55	±
156	18	13.50	17.95	2.42	13.46	55	53	— 60
157	16	12.50	19.00	2.37	14.84	49	52	+ 90
158	19	18.00	14.40	2.59	13.64	58	56	— 60
159	22	16.00	19.40	3.10	14.11	67	68	+ 30
160	26	18.50	18.00	3.33	12.69	79	73	—1 80

TABLE I. — *Concluded.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
161	21	16.5	12.80	2.11	10.06	$0 64	$0 46	—$5 40
162	51	37.0	19.60	7.25	14.22	1 56	1 59	+ 90
163	55	44.5	15.70	6.98	12.70	1 68	1 53	—4 50
164	55	46.5	18.00	8.37	15.22	1 68	1 83	+4 50
165	37	28.5	18.80	5.36	14.48	1 13	1 17	+1 20
	5,659	-	-	790.77	-	$172 61	$172 60	-

Comments on Table I.

Column 1 represents the number of each patron; column 2, the number of spaces; column 3, the pounds of cream; column 4, the per cent. of fat in cream; column 5, the pounds of fat actually furnished by each patron in one day's cream. Column 6, showing the pounds of butter fat in 100 spaces of each patron's cream, is calculated for the sake of comparison. Column 7 represents the value of the cream at the price per space paid by the creamery at the time. Column 8 shows the value of the cream by Babcock test, on the basis of 21.83 cents per pound of butter fat. This value per pound of fat was determined by taking the value of the cream as represented by the space system, and dividing it by the number of pounds of butter fat actually found in the cream. The quotient showed the price per pound of butter fat. Column 9 shows whether payment by the Babcock test would be more or less than by the space system for thirty days.

It will be seen that the percentage of fat in the cream varies very much. The extremes are 11 and 22 per cent.

The pounds of butter fat in 100 spaces of each patron's cream differ also widely, the extreme being 8.90 pounds and 17.63 pounds.

Attention is also called to the last column, which makes emphatic that by the Babcock system those patrons furnishing the better to best qualities of cream would be paid more, and those furnishing the poorer qualities would be paid less, than by the present system.

Summary of Table I., showing Butter Equivalent from 100 Spaces of Graded Cream, and Value of Same.

Pounds of Butter Fat from 100 Spaces of Cream.	Number of Patrons.	Per Cent. of Patrons.	Equivalent to Butter. Pounds.	Value of Butter at 25 Cents per Pound.
8-12,	10	6.1	13.42*	$3 35
12-13,	23	14.0	14.58	3 64
13-14,	52	31.5	15.75	3 94
14-15,	41	24.9	16.92	4 23
15-16,	30	18.2	18.08	4 52
16-18,	9	5.5	19.83	4 96

* Figured on the basis of 11.5 pounds of butter fat.

This summary gives us at least a comparative idea of the different qualities of cream furnished, and their approximate values in butter. It brings out the variations in a very striking manner, and needs no further explanation.

Is the Weight of the "Space" Constant?

In order to show the variations, the weight per space of the cream collected from thirty-six different patrons on two consecutive days is given in Table II. Beginning from the left, each fraction of a pound shows the weight of a space of each patron's cream.

TABLE II.

First Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9,	.713	.948	.682	.785	.802	.833	.662	.695	.714
" 10-18,	.840	.760	.768	.750	.705	.685	.775	.704	.758
" 19-27,	.766	.743	.786	.788	.809	.716	-	.720	.773
" 28-36,	.800	.971	.875	.725	.785	.765	.862	.792	.709

Average weight of a space, ...750 pounds.

TABLE II. — *Concluded.*

Second Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9, ...	.741	.756	.750	.772	.781	.830	.713	.750	.758
" 10-18, ...	.850	.770	.759	.875	.791	.783	.747	.784	.798
" 19-27, ...	.750	.766	.795	.745	.813	.702	.822	.743	.786
" 28-36, ...	.766	1.020	.887	.750	.785	.802	.850	.818	.696

Average weight of a space, ...766 pounds.

Comments on Table II.

Having noted in Table I. the data, showing the wide differences existing in the *composition* of the space as furnished by different patrons, one has only to examine Table II. to note equally as wide differences in the *weight* of the space. One could not fail to note these differences when weighing the different lots of cream, twenty-five spaces from one patron often showing a different weight from a like amount furnished by another.

Is the Babcock test reliable?

Can a pound of butter always be made from the same number of spaces?

In order to illustrate these points, the cream of three patrons was churned separately. No. 1 was a poor cream, No. 2 a good cream and No. 3 a cream of fair quality. The cream was weighed, the number of spaces noted, as well as the per cent. of butter fat it contained. The butter produced from each cream was also weighed, as well as the buttermilk, and tested for the per cent. of butter fat. The per cent. of water in each of the different samples of butter was also determined.

TABLE III. — *Showing Results of the Test.*

NUMBER.	Number of Spaces.	Weight of Cream (Pounds).	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Butter made.	Per Cent. of Fat in Butter.	Pounds of Fat in Butter.	Pounds Buttermilk.	Pounds Fat in Buttermilk.	Total Fat in Butter and Buttermilk.
1, ...	17	14	12.0	1.68	2.50*	61.45	1.53	17.5	0.14	1.67
2, ...	25	17.5	20.4	3.57	4.50	76.73	3.45	15.0	0.05	3 50
3, ...	25	19.5	17.0	3.32	4.25	75.30	3.20	33.5	0.03	3.23

* Not salted, but equal to about 2.60 pounds salted butter.

The above table shows the reliability of the Babcock test. Please notice that in the cream churned there were 1.68, 3.57 and 3.32 pounds of butter fat respectively, and we accounted for by means of this test 1.67 pounds, 3.50 pounds and 3.23 pounds. In the process of manipulation small fractions are of course lost; the results, however, tally very closely, and as near as one could expect or ask for.

Composition of the Butter.

	No. 1.*	No 2.	No. 3.
Water, ...	31.85	13.61	17.80
Fat, ...	58.48	76.73	75.30
Salt and curd, ...	9.67	9.67	6.90

* Calculated on salt and curd basis of No. 2; this butter was not salted.

Attention is called to the very large amount of water in No. 1, and the consequent low percentage of butter fat. The butter maker reported that it was impossible to work out more water. The butter had a very inferior appearance. Numbers 2 and 3 looked well.

Spaces to the Pound.

(*a*) *Butter Maker's Report.*

	I.	II.	III.
Spaces per pound salted, . . .	6.41	5.55	5.88

(*b*) *On the Basis of Same Amount of Water as found in No. II.*

Spaces per pound salted, . . .	8.29	5.55	6.19

These results make very clear that, other things being equal, the number of spaces required to make a pound of butter of *like water content* depends entirely upon the amount of butter fat in the cream; and it is very strange that farmers will be so blind to their own interest as to fail to recognize this fact. Cream will make butter *in proportion to the amount of butter fat it contains.*

CONCLUSIONS.

The results obtained fully confirm the investigations made along this line elsewhere.

They show conclusively that the space of cream is of very variable composition, and is not a true measure of the value of cream for butter purposes. The value of cream for butter, other things being equal, depends entirely upon the amount of butter fat it contains. The number of spaces of cream required to make a pound of butter depends also upon the butter fat content of the cream.

The Babcock test is perfectly reliable, and this system can be applied practically to determine the value of cream raised by the deep-setting process.

VI.

I. FIFTH FEEDING EXPERIMENT WITH STEERS.

By J. B. Lindsey.

1893–94.

General Description.

The experiment here described is a continuation of those published in our previous reports.

Three grade Durham steers, yearlings, weighing about 600 pounds each, were used in the experiment. They were quite thin when first received, and cost 3 69 cents per pound live weight.

The coarse foods fed were raised upon the station grounds, and consisted principally of corn ensilage, corn stover, vetch and oats and a variety of green crops with some roots. The corn for ensilage was cut just as the kernels were glazing. The corn stover was the corn plant remaining after the fully matured ears had been removed. The grains fed were wheat bran, Buffalo gluten feed, new-process linseed meal, corn and cob meal, cotton-seed meal and oat feed. The quantity of coarse fodders fed depended in all cases upon the individual appetite of the animals

The animals were fed and watered twice each day, between six and seven o'clock in the morning and at five in the afternoon, one-half of the food being given at each time. About one ounce of salt was added to the grain feed daily. Whenever the weather permitted, the steers were allowed the use of the barn-yard for at least one-half a day. They were kept well carded.

The weights of the animals were taken weekly, before being watered in the morning.

THE REASONS FOR THE EXPERIMENT.

I. To note the effect of distinct fodder rations upon the production of live weight.

II. To secure facts relating to the actual cost of beef production in Massachusetts under existing local conditions.

III. To compare the relative merits and cost of pasture *vs.* soiling during the summer season.

I. EFFECT OF DISTINCT FODDER RATIONS UPON THE PRODUCTION OF LIVE WEIGHT.

Average Composition of the Daily Fodder Rations (1893–94).

I		II.	
May 16 to June 8.		*June 21 to July 4.*	
Buffalo gluten feed,	3.00 lbs.	Buffalo gluten feed,	3.00 lbs.
New-process linseed meal,	2.00 “	New-process linseed meal,	2.00 “
Soja-bean and corn ensilage,	39.38 “	Rowen,	14.00 “
Nutritive ratio,	1:5.51	Nutritive ratio,	1:4.64
Total cost,	10.86 cts.	Total cost,	15.95 cts.
Manurial value obtainable,	6.99 “	Manurial value obtainable,	9.32 “
Net cost,	3.87 “	Net cost,	6.63 “

III.		IV.	
November 7 to November 20.		*November 28 to January 2.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
New-process linseed meal,	3.00 “	New-process linseed meal,	3.00 “
Corn stover,	15.33 “	Corn stover,	12.07 “
Nutritive ratio,	1:6.29	Roots,*	15.00 “
Total cost,	10.57 cts.	Nutritive ratio,	1:6.10
Manurial value obtainable,	10.18 “	Total cost,	12.75 cts.
Net cost,	0.39 “	Manurial value obtainable,	10.45 “
		Net cost,	2.30 “

V.		VI.	
January 27 to February 11.		*March 1 to March 27.*	
Buffalo gluten feed,	4.00 lbs.	Cotton-seed meal,	4.00 lbs.
Oat feed,	4.00 “	Corn and cob meal,	4.00 “
Corn stover,	4.00 “	Corn stover,	4.00 “
Corn ensilage,	28.91 “	Corn ensilage,	42.39 “
Turnips,	15.00 “	Nutritive ratio,	1:6.25
Nutritive ratio,	1:8.73	Total cost,	15.30 cts.
Total cost,	15.49 cts.	Manurial value obtainable,	10.10 “
Manurial value obtainable,	10.61 “	Net cost,	5.20 “
Net cost,	4.88 “		

* Potatoes or mangolds.

Summary of Cost of the Average Daily Fodder Rations.

[Cents.]

	FEEDING PERIODS.					
	I.	II.	III.	IV.	V.	VI.
Total cost,	10.86	15.95	10.57	12.75	15.49	15.30
Manurial value obtainable,*	6.99	9.32	10.18	10.45	10.61	10.10
Net cost,	3.87	6.63	0.39	2.30	4.88	5.20

Gain required per Day in Pounds of Live Weight to cover Cost of Feed.

Total cost,	2.82	4.14	2.74	3.31	4.02	4.00
Net cost,	1.00	1.72	0.10	0.60	1.27	1.35

Live Weight actually produced per Day.

	1.50	0.88	0.93	0.95	1.87	0.81

Cost of Feed per Pound of Live Weight gained.

Total cost,	7.24	18.01	11.36	13.42	8.29	18.88
Net cost,	2.56	7.53	0.43	2.42	2.61	6.42

* Allowing 90 per cent. of the fertilizing ingredients to be recovered in the manure.

The periods in which ensilage was fed as the coarse fodder produced distinctly the largest gains in live weight. The hay ration (Period II.) was the most costly one.

II. WHAT IT HAS COST TO PRODUCE BEEF.

Below is presented a detailed account of the cost of the foods consumed. The cost of labor, interest on the money involved, etc., is not added.

The steers were purchased March 28, 1893, at 3.69 cents per pound live weight, and were sold April 4, 1894, for 3.85 cents per pound live weight. It is to be noted that these animals were bought when beef was high and of necessity sold when it was low, which will naturally not be favorable to a successful financial operation. They were soiled during the summer of 1893.

The three steers consumed nearly the same amount of food, only slight differences being noted in the coarse fodders.

Record of Feed consumed.

[Average.*]

FODDER ARTICLES.	Feed consumed (Pounds).	Dry Matter (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran,	675	600.75	$6 41	$3 98	$2 43
Buffalo gluten feed,	476	437.92	4 52	2 70	1 82
New-process linseed meal,	705	630.13	9 52	7 47	2 05
Cotton-seed meal,	168	154.56	2 26	2 13	13
Corn and cob meal,	161	123.97	1 45	47	98
Oat feed,	96	89.28	91	34	57
Rowen,	869	770.80	6 51	3 37	3 14
Soja-bean and corn ensilage,	2,569	570.03	3 52	2 04	1 48
Corn ensilage,	2,725	572.20	3 41	1 42	1 99
Corn stover,	1,256	954.56	3 13	3 77	64
Corn fodder,	314	59.66	39	14	25
Vetch and oats,	552	138.00	76	47	29
Buckwheat,	1,389	208.35	1 74	1 33	41
Cabbage,	1,200	156.00	1 50	1 34	16
Other green crops,	1,652	330.00	2 07	1 49	58
Turnips and potatoes,	735	90.00	92	40	52
Beets,	615	100.24	1 23	50	73
	–	6,746.45	$50 25	$33 36	$16 89

* The steers consumed approximately the same quantities of food during the entire experiment, only slight difference in coarse fodders being noted.

Steer I.

	Pounds.
Live weight of animal when purchased,	557.00
Live weight of animal when sold,	1,107.00
Total gain during experiment,	550.00
Average gain in weight per day,	1.47
Dry matter required to produce one pound live weight,	12.26

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 55	–
Total cost of feed,	50 25	–
Selling price of steer, 1,107 pounds, at 3.85 cents.	–	$42 61
Value of manure produced,	–	33 36
	$70 80	$75 97

	Cents.
Total cost of feed per pound live weight actually produced,	9.14
Net cost of feed per pound live weight actually produced,	3.07
Total cost to us of one pound live beef,	6.39

Steer II.

	Pounds.
Live weight of animal when purchased,	517.00
Live weight of animal when sold,	1,045.00
Total gain during experiment,	528.00
Average gain in weight per day,	1.41
Dry matter required to produce one pound live weight,	12.78

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$19 08	–
Total cost of feed,	50 25	–
Selling price of steer, 1,045 pounds, at 3.85 cents.	–	$40 23
Value of manure produced,	–	33 36
	$69 33	$73 59

	Cents.
Total cost of feed per pound live weight actually produced,	9.52
Net cost of feed per pound live weight actually produced,	3.20
Total cost to us of one pound live beef,	6.63

Steer III.

	Pounds.
Live weight of animal when purchased,	550.00
Live weight of animal when sold,	1,137.00
Total gain during experiment,	587.00
Average gain in weight per day,	1.57
Dry matter required to produce one pound live weight,	11.49

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 30	–
Total cost of feed,	50 25	–
Selling price of steer, 1,137 pounds, at 3.85 cents.	–	$43 77
Value of manure produced,	–	33 36
	$70 55	$77 13

	Cents.
Total cost of feed per pound live weight actually produced,	8.57
Net cost of feed per pound live weight actually produced,	2.87
Total cost to us of one pound live beef,	6.20

Summary of Three Steers.

	Pounds.
Live weight of animals when purchased,	1,624.00
Live weight of animals when sold,	3,289.00
Total gain during experiment,	1,665.00
Average gain in weight per day,	1.48
Dry matter required to produce one pound live weight,	12.32

Financial Statement.

	Debit.	Credit.
Original cost of steers,	$59 93	–
Total cost of feed,	150 75	–
Selling price of steers,	–	$126 61
Value of manure produced,	–	100 08
	$210 68	$222 69

	Cents.
Total cost of feed per pound live weight actually produced,	9.08
Net cost of feed per pound live weight actually produced,	3.04
Total cost to us of one pound live beef,	6.41
Net cost to us of one pound live beef,	3.36

The total cost of the 3,289 pounds of live beef actually sold was 6.41 cents per pound, and the net cost, found by deducting the manure reckoned at a maximum value, is 3.36 cents. The steers were sold at 3.85 cents per pound live weight. The animals gained 1.48 pounds live weight daily during the entire experiment. We hardly think it possible to secure better results with the average grade steer. The results, however, make an unfavorable financial showing. (See discussion of results in the general summary of steer-feeding experiments.)

III. SUMMER SOILING *vs.* PASTURE.

This experiment was an exact repetition of the one described in the report for 1893.

The three steers were kept in the barn or turned into the barn-yard during the summer and fall months, and fed upon a variety of green crops raised upon the station grounds in combination with various grains.

Feed consumed by Each Steer during Summer Soiling.

[As the different steers consumed practically the same amount of feed, one statement for the three will suffice.]

FODDER ARTICLES.	Feed Consumed (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Buffalo gluten feed,	253.50	$2 40	$1 43	$0 97
New-process linseed meal,	367.00	4 95	3 89	1 06
Wheat bran,	205.50	1 95	1 21	74
Soja-bean and corn ensilage,	160.70	2 20	1 27	93
Rowen,	677.00	5 07	2 62	2 45
Vetch and oats (green),	552.00	76	47	29
Other green crops,	1,442.00	1 80	1 30	50
Buckwheat,	1,389.00	1 74	1 33	41
Corn fodder,	314.00	39	14	25
Cabbages,	800.00	1 00	90	10
	-	$22 26	$14 56	$7 70

Summer Soiling compared with Pasture.

	SUMMER SOILING.			PASTURE.		PASTURE.	SOILING.
	Steer I.	Steer II.	Steer III.	Average Two Steers. **1890.**	Average Three Steers. **1891.**	Average Five Steers.	Average Three Steers.
Date of beginning experiment,	May 1,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	578	552	630	867	828	-	-
Live weight of steers at end of experiment (pounds),	880	912	835	971	935	-	-
Total weight gained (pounds),	302	360	205	104	107	106	289
Average gain in weight per day (pounds),	1.97	2.35	1.34	0.72	0.57	0.63	1.89
Total cost of feed per day, soiling (cents),	14.55	14.55	14.55	-	-	-	14.55
Net cost of feed per day, soiling (cents),	5.03	5.03	5.03	-	-	-	5.03
Total cost of feed per day at 40 cents per week for pasture (cents),	-	-	-	5.71	3.57*	4.64	-
Total cost of feed required to produce one pound of live weight (cents),	7.38	6.19	10.85	8.24	6.36	7.30	8.14
Net cost of feed required to produce one pound of live weight (cents),	2.55	2.14	3.76	-	-	-	2.82

* Allowing 25 cents per week for pasture.

The results make as good if not a better showing than those reported last year. The comparative merits of soiling *vs.* pasture are briefly discussed in the general summary of steer-feeding experiments.

Additional Data of the Experiment.

Local Market Cost, per Ton, of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
New-process linseed meal,	27 00
Oat feed,	19 00
Cotton-seed meal,	27 00
Corn and cob meal,	18 00
English hay,	15 00
Vetch and oats (dry),	15 00
Rowen,	15 00
Corn and soja-bean ensilage,	2 75
Turnips,	2 50
Potatoes,	2 50
Mangolds,	4 00
Corn stover,	5 00
Corn ensilage,	2 50
Other green crops,	2 50

Analyses of Fine Feeds.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture at 100° C.,	11.00	8.00	10.62	7.00	9.00	23.00
Dry matter,	89.00	92.00	89.38	93.00	91.00	77.00
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	8.00	1.00	5.89	4.61	7.10	1.64
" cellulose,	11.00	7.00	8.84	17.73	5.53	7.54
" fat,	5.00	14.30	3.94	3.95	9.66	4.19
" protein,	18.00	23.60	40.79	11.02	50.34	10.00
Nitrogen free extract,	58.00	54.10	40.54	62.69	27.37	76.63
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture,	11.00	8.00	10.62	7.00	8.00	23.00
Nitrogen,	2.55	3.47	5.83	1.63	6.88	1.23
Phosphoric acid,	2.46	0.35	1.95	1.25	2.37	0.70
Potassium oxide,	1.58	0.10	1.08	0.80	1.70	0.40
Valuation per 2,000 pounds,	$13 12	$12 14	$23 53	$7 83	$32 24	$5 44
Manurial value obtainable,	11 81	11 34	21 18	7 05	29 00	4 90

Analyses of Coarse Fodder Articles.

[Per Cent.]

FODDER ANALYSES.	Rowen.	Corn and Sojabean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture at 100° C.,	11.30	77.77	79.00	24.00	90.00	78.67	83.71
Dry matter,	88.70	22.23	21.00	76.00*	10.00	21.33	16.29
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.48	9.48	4.53	7.14	8.83	4.76	6.79
" cellulose,	30.00	26.63	33.30	33.38	11.75	2.30	5.84
" fat,	4.23	3.75	4.28	1.59	1.68	0.62	0.71
" protein,	12.11	7.91	6.31	9.91	10.37	9.56	13.27
Nitrogen-free extract,	47.18	52.23	51.58	47.98	67.37	82.76	73.39
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Eighty-three per cent. dry matter during January, February and March.

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Rowen.	Corn and Soja-bean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture,	11.30	77.77	79.00	20.00	90.00	78.67	83.71
Nitrogen,	1.72	0.32	0.21	1.27	0.16	0.33	0.35
Phosphoric acid,	0.46	0.12	0.03	0.30	0.12	0.13	0.11
Potassium oxide,	1.97	0.48	0.41	1.70	0.38	0.59	0.46
Valuation per 2,000 pounds,	$8 64	$1 77	$1 17	$6 67	$0 96	$1 94	$1 82
Manurial value obtainable,	7 77	1 59	1 05	6 00	86	1 75	1 64

Fertilizing Constituents of "Other Green Crops."

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Vetch and Oats.	Buckwheat.	Cabbages.	Corn Fodder.	Other Green Crops.
Moisture,	75.00	85.00	87.00	81.00	80.00
Nitrogen,	0.44	0.44	0.53	0.18	0.43
Phosphoric acid,	0.13	0.09	0.21	0.15	0.15
Potassium oxide,	0.42	0.54	0.39	0.33	0.35
Valuation per 2,000 pounds,	$2 13	$2 15	$2 50	$1 01	$2 00
Manurial value obtainable,	1 70	1 93	2 25	90	1 80

The various leguminous and non-leguminous crops above referred to were fed in small quantities, and it has only been possible to attempt an approximate manurial value.

2. GENERAL SUMMARY OF FEEDING EXPERIMENTS WITH GROWING STEERS.

By J. B. Lindsey.

1890–94.

A series of feeding experiments with growing steers has been carried on at the station since December, 1890, and the details published in the successive annual reports. The last experiment was completed in April, 1894. It seems proper at this time to attempt to present a *general summary* of the results obtained.

The steers experimented with during these four to five years were ten in number, of which seven were grade Shorthorns and three grade Durhams. They were generally bought in the autumn, and weighed about 600 pounds each. These were termed "yearlings." At the beginning of the second winter season they had increased to about 1,000 pounds weight, and were termed "two-year-olds." There was one exception in case of the three steers fed during 1893; these were purchased in the spring of 1893, soiled during the summer and sold in the spring of 1894. Five of the steers were pastured during the summer and five were soiled.

Among the questions to which answers were sought were the following: —

I. What are the most economical fodder rations for beef production?

II. The actual cost of beef production in Massachusetts under existing local conditions.

III. The average daily gain in live weight during an entire experiment.

IV. Dry matter required to produce one pound of live weight.

V. The relative merits and cost of pasture *vs.* soiling during the summer season.

RESULTS OF THE EXPERIMENT.

The Most Economical Rations for Beef Production.

Yearlings.

ARTICLES OF FODDER.	AVERAGE DAILY GAIN IN LIVE WEIGHT (POUNDS).			
	1889-90.	**1890-91.**	**1891-92.**	Average.
Grain and corn stover,	1.30*	-	0.75	1.03
Grain and corn ensilage,	2.92	1.40	1.55	1.96
Grain and corn fodder,	1.55*	-	-	1.55
Grain, corn stover and sugar beets,	0.78	-	-	0.78
Grain, hay and roots,	-	1.49	2.04	1.76

* More than the ordinary amount of grain.

Digestible Matter in Above Rations.

ARTICLES OF FODDER.	DIGESTIBLE MATTER CONSUMED DAILY PER 1,000 POUNDS LIVE WEIGHT (POUNDS).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover,	9.95	1.69	7.81	0.43	1:5.20
Grain and corn ensilage,	13.96	2.56	10.60	0.85	1:5.10
Grain and corn fodder,	13.63	2.47	10.56	0.60	1:4.90
Grain, corn stover and sugar beets,	11.15	2.13	8.54	0.48	1:4.60
Grain, hay and roots,	13.52	2.49	10.42	0.59	1:5.00
Wolff's standard,	15.08	2.17	12.54	0.37	1:6.25

Two-year-olds.

ARTICLES OF FODDER.	AVERAGE DAILY GAIN IN LIVE WEIGHT (POUNDS).					
	1889-90.	**1890-91.**	**1891-92.**	**1892-93.**	**1893-94.**	Average.
Grain and corn stover,	-	-	-	0.98	0.93	0.95
Grain and corn ensilage,	3.84	1.57	1.44	1.84	1.15	1.97
Grain, hay and straw,	-	1.61	-	-	-	1.61
Grain, hay and roots,	-	1.65	1.15	-	-	1.40

Digestible Matter in Above Rations.

ARTICLES OF FODDER.	DIGESTIBLE MATTER CONSUMED DAILY PER 1,000 POUNDS LIVE WEIGHT (POUNDS).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover,	10.27	1.53	8 36	0.38	1:6.2
Grain and corn ensilage,	11.89	1.94	9.22	0.70	1:5.6
Grain, hay and straw,	13.27	2.61	9.93	0.72	1:4.5
Grain, hay and roots,	11.94	2.18	9.24	0.51	1:5.0

Summary of Cost of the Average Daily Fodder Rations.

Yearlings.

ARTICLES OF FEED.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover,	10.06	3.86
Grain, corn stover and sugar beets,	14.98	7.54
Grain and corn ensilage,	13.47	5.96
Grain and corn fodder,	12.45	4.80
Grain, hay and roots,	15.92	8.83

Two-year-olds.

Grain and corn stover,	9.98	2.12
Grain and corn ensilage,	15.81	6.92
Grain, hay and straw,	16.78	6.85
Grain, hay and roots,	22.63	12.79

Cost of Feed per Pound of Live Weight gained.

Yearlings.

ARTICLES OF FEED.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover,	9.77	3.14
Grain, corn stover and sugar beets,	19.20	9.66
Grain and corn ensilage,	6.87	2.10
Grain and corn fodder,	8.04	3.10
Grain, hay and roots,	9.05	5.02

Two-year-olds.

ARTICLES OF FEED.	Total Cost.	Net Cost.
Grain and corn stover,	10.50	2.23
Grain and corn ensilage,	8.02	3.51
Grain, hay and straw,	10.42	4.25
Grain, hay and roots,	16.16	9.13

What the Above Tables teach.

(*a*) *Relative Average Gain.*

The chief coarse fodders fed were corn stover, corn fodder, corn ensilage and hay and roots. It is to be observed that in case of both yearlings and two-year-olds the *greatest daily gain* was made when the coarse fodder consisted of corn ensilage. Corn fodder and hay and roots also made a very fair showing. In comparing the table of growth and digestible matter consumed it will be observed that a very close relation exists between them. The more digestible matter consumed, the greater the daily gain. Thus in the case of both yearlings and two-year-olds in 1889–90 the gain in live weight during the ensilage period was exceptionally high.

On referring to the tables published in the annual report for 1892, page 166, it will be seen that the steers consumed a very large amount of food during that time, and to this large food consumption must be attributed the large gain in weight. In case of corn stover as a coarse feed the gain with one exception was small, being about nine-tenths of a pound daily. This is due without doubt to the fact that the total amount of digestible matter consumed during the corn-stover period was relatively small. Corn stover, when fed as a part of the daily coarse fodder ration, makes a valuable food, but when given as a coarse feed exclusively the animals will not consume a quantity sufficient to produce the requisite gain. It has not the sweet taste of the hay, nor the sour, appetizing taste of the ensilage.

On comparing the daily gains with the amount of digestible matter consumed daily, it must be admitted that for an equal amount of digestible matter the corn ensilage rather exceeds all other coarse fodders.

(*b*) *Cost of Daily Gain.*

In comparing the cost of feeds required to produce one pound of live weight, it will be seen that *the relative cost was higher with two-year-olds than with yearlings.* This is in accordance with general teaching.

Again, live weight was produced at the lowest cost both with yearlings and two-year-olds when corn ensilage was the principal coarse fodder of the daily ration. The corn fodder ration is the next higher in cost, and then follow the corn stover and finally, as the highest, the hay ration. When the net cost of feed per pound of live weight gained is considered, the corn-stover period compares very favorably with the ensilage and corn-fodder periods.

In the grain addition to the coarse fodders the point has been to so combine them as to get from 2 to 2.5 pounds of digestible protein in the daily ration.

I. To produce beef, then, at the lowest cost, grow and feed those coarse fodders that yield the largest returns of digestible matter per acre at the least cost of production. Such coarse fodders are corn ensilage, corn fodder and, when properly fed, corn stover.

II. These coarse fodders must be supplemented with concentrated feeds, so as to secure 2 to 2.5 pounds of digestible protein per 1,000 pounds live weight, thus furnishing a ration having a nutritive ratio of 1 : 5 to 1 : 6.

III. In order to secure maximum growth the rations must be palatable as well as properly balanced.

We have no long feeding periods with green crops excepting corn fodder; but our observations teach that vetch and oats is an excellent economical green fodder. Experiments are in progress to ascertain those green crops that are best suited to our conditions and will give a large yield of palatable fodder.

Daily Fodder Rations for Growing Steers.

Yearlings.

I.		II.	
Buffalo gluten feed,	3 qts.	Wheat bran,	4 qts.
Cotton-seed meal,	1½ "	Buffalo gluten feed,	3 "
Corn stover (dry),	8 lbs.	Corn ensilage,	40 lbs.
Hay,	5 "		
III.		**IV.**	
Chicago gluten meal,	2 qts.	Wheat bran,	4 qts.
Wheat bran,	4 "	New-process linseed meal,	2 "
Corn fodder,	35 lbs.	Green fodder,	40 lbs.

Two-year-olds.

I.		II.	
Buffalo gluten feed,	4 qts.	Wheat bran,	5 qts.
Wheat bran,	5 "	Cotton-seed meal,	2 "
Corn stover,	9 lbs.	Corn ensilage,	50–60 lbs.
Vetch and oats (dry),	7 "		
III.		**IV.**	
Chicago gluten meal,	3 qts.	Corn meal,	4 qts.
Wheat bran,	5 "	New-process linseed meal,	3 "
Corn fodder,	50–60 lbs.	Green fodder,	60 lbs.

The grain feed in the above rations can be used interchangeably with the coarse fodders. They are so combined as to furnish the necessary amount of protein. One must select the various grains with reference to their cost at the time of feeding them.

The Cost of Beef Production.

In the following table will be found a summary of the financial returns from the ten steers.

It will be remembered that five of the steers were pastured during the summer and five were soiled. The object ever has been to combine the feeds so as to get low-cost rations that would at the same time produce maximum growth.

Financial Statement.

	Debit.	Credit.
Original cost of steers, 6,237 pounds, at 3.55 cents,	$221 27	–
Total cost of feed, ...	596 23	–
Selling price of steers, 11,874 pounds, at 3.88 cents,	–	$460 91
Value of manure produced, ...	–	302 53
	$817 50	$763 44

Total gain in live weight, ...	5,637.00 lbs.
Total cost of feed to produce one pound live weight, . .	10.58 cts.
Net cost of feed to produce one pound live weight, . .	5.56 "
Total cost to us of one pound live beef, ...	6.89 "
Net cost to us of one pound live beef, ...	4.34 "
Average gain in weight per day, ...	1.24 lbs.
Dry matter required to produce one pound live weight,* .	11.32 "

* For five steers that were soiled.

Remarks on the Above Figures.

It is to be observed that the above results are not at all encouraging. The first cost of the steers plus the feed consumed amounts to more than the returns from the beef plus the value of manure reckoned at a maximum price.

The cost of feed to produce a pound of live weight has been 10.58 cents, while the total cost to us of a pound of live weight (obtained by adding to the original cost of the steers the cost of the feed consumed, and dividing by the pounds of live weight sold) is 6.89 cents. The net cost to us of a pound of live beef reckoned in the same way is 4.34 cents. Only by reckoning the manure at a maximum value have we been able to produce live beef at 4.34 cents per pound, the cost of attendance not being included. It must be remembered, however, that our coarse fodders and grains were charged at market rates.

While the results do not present a favorable financial showing, they teach several lessons. In the first place, the writer thinks it would be policy to begin with calves instead of 600-pound steers. The rate of growth of very young stock is much more rapid, and it would be interesting to see if they could not be grown cheaper than they could be purchased. In the second place, more attention must be given to the kind of steer grown. We must have steers that will grow more rapidly than those experimented with. Just as there are good and poor milch cows, so there are good and poor growing steers. Feed, it must be remembered, is only secondary. We must first have the cow bred with a capacity for milk production, and then help her to produce maximum yields by properly feeding her; and in just the same way we must have the steer so bred as to grow rapidly, then, by judicious and economical feeding, seek to get the greatest growth at the minimum cost for feed. The writer believes that by beginning with young calves from animals that have extra reputation for rapid growth, and following a judicious system of feeding, it will yet be possible to produce beef economically in Massachusetts.

Summer Soiling vs. Pasture.

	SUMMER SOILING.		PASTURE.		AVERAGE SOILING.	AVERAGE PASTURE.
	Average Two Steers. **1892.**	Average Three Steers. **1893.**	Average Two Steers. **1890.**	Average Three Steers. **1891.**	Average Five Steers.	Average Five Steers.
Date of beginning experiment,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	822	587	867	828	704	847
Live weight of steers at end of experiment (pounds),	1,027	876	971	935	951	953
Total weight gained (pounds),	205	289	104	107	247	106
Average gain in weight per day (pounds),	1.37	1.89	0.72	0.57	1.63	0.63
Total cost of feed per day, soiling (cents),	12.72	14.55	-	-	13.63	-
Net cost of feed per day, soiling (cents),	6.18	5.03	-	-	5.61	-
Total cost of feed per day at forty cents per week for pasture (cents),	-	-	5.71	3.57*	-	4.64
Total cost of feed required to produce one pound live weight (cents),	9.37	8.14	8.24	6.36	8.75	7.30
Net cost of feed required to produce one pound live weight (cents),	4.55	2.82	-	-	3.68	-

* Allowing twenty-five cents per week for pasture.

It will be seen from the above table that the animals soiled made fully two and one-half times the daily gain as did the pasture lots. This is probably due to an abundance of food on the part of the soiled steers. The pastures were what were termed "good" by the average farmer.

The total cost of feed to produce a pound of live weight is about the same in each case. In case of the soiled animals, however, the manure is left upon the farm. If one might assume that the value of the manure from a commercial standpoint would about pay for cost of attendance, the conditions would appear to be about equal. It must not be forgotten, however, that all of the coarse fodders grown upon the place were charged at market rates.

The writer thinks, judging from the above results, that no absolute rule can be laid down to govern all cases. Local conditions and circumstances would undoubtedly be the determining factors. Other things being equal, steers can at least be as economically grown by soiling as by pasturing.

VII.

FEEDING CALVES FOR VEAL.

By J. B. Lindsey.

In our annual report for 1893 was presented an experiment in feeding very young calves with skim-milk alone and with skim-milk combined with various grains. The calves were sold for veal when from seven to ten weeks old. The object was to inquire into the price that could be obtained for the skim-milk per quart when fed to calves and pigs. The results were as follows: —

Calves. — Summary of Results.

1. Price returned per quart for skim-milk, when live weight sells at 4½ cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.77
Calves 5, 6 and 7 (skim-milk alone),	0.75
Average of seven calves,	0.76

2. Price returned per quart for skim-milk, when live weight sells at 4 cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.64
Calves 5, 6 and 7 (skim-milk alone),	0.63
Average of seven calves,	0.63

Price obtained for Skim-milk per Quart when fed to Pigs.

Here follow the average results obtained from experiments with forty pigs, being six distinct lots, fed during the years 1890–91 and 1892–93. In this number grade Chester Whites predominated, but several Yorkshires, Berkshires, Poland Chinas and Tamworths are also included.

Statement.

[Cents.]

Dressed Pork sold at—	5½ Cents.	6 Cents.	6½ Cents.	7 Cents.	7½ Cents.	8 Cents.
Price returned per quart for skim-milk fed, . . .	0.21	0.30	0.46	0.58	0.70	0.81

COMMENTS ON CALF-FEEDING EXPERIMENT (1893).

The experiment has shown that calves grown upon skim-milk alone or upon skim-milk and grains during the first eight weeks of their lives make good gains in live weight, namely, from 0.9 to 2.13 pounds per day, with an average of 1.49 pounds. These animals, however, put on very little fat, either when fed on skim-milk alone or when fed on skim-milk and grains. They were not able to digest the necessary amount of corn meal, Buffalo gluten feed, wheat flour or middlings, when fed in connection with the nitrogenous milk, to promote the formation of fat.

The meat of the animals thus described was quite white in appearance, but not as tender as calves that were fed whole milk. The ribs and flanks of animals thus fed were thinner than those consuming whole milk, and the shrinkage in dressing was from 5 to 7 per cent. more.

OBJECTS OF THE PRESENT EXPERIMENT (1894).

I. To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

II. To see if this mixture would fatten calves economically.

RESULTS OF THE EXPERIMENT.

I. By feeding, in addition to skim-milk, oleomargarine, cotton-seed oil, corn oil and brown sugar, calves were grown to weigh 160 pounds when seven weeks old. These calves were fairly fat, showing a better condition than calves fed on skim-milk entirely, but were not equal to sucking calves.

II. The experiment was not a financial success, however, the increased price obtained for the calves being more than counterbalanced by the cost of the fats and the extra labor in preparing the food.

III. In one case (calf 7), where oleomargarine and brown sugar were fed in addition to the skim-milk, the result was decidedly encouraging. The calf was in good condition, and returned 0.91 of a cent per quart for the skim-milk fed.

THE EXPERIMENT EXPLAINED.

How the Artificial Milk was prepared.

The object was, if possible, to make an emulsion of the fat or oil with the skim-milk. For this purpose a tin vessel, very much resembling the ordinary creamery can, was made. It was twenty-two inches deep and six inches in diameter. There was a "dasher," which consisted simply of a rod about eight inches longer than the depth of the can, made of tin (or wood), to one end of which was fastened a perforated tin disk. The disk was of such a diameter that it could be worked up and down easily in the can, which was provided with a cover with a hole in the centre, through which the rod protruded. A cheap grade of oleomargarine was first used. It was added to the skim-milk and the latter heated to 110° F. This melted the "oleo," and the solution was then transferred to the tin churn and worked for several minutes. By this method the oil was quite well mixed with the milk, and the resulting solution had a very pleasant smell, closely resembling that of new milk. It was fed in a Small's calf-feeder, and the calves drank it readily. The artificial milk had practically the following composition, as compared with ordinary pure milk: —

	Artificial Milk (Per Cent.).	Pure Milk (Per Cent.).
Water, ...	86.60	87.00
Total solids, ...	13.40	13.00
Fat, ...	3.78	4.00

The above analysis of artificial milk represents one ounce of "oleo" to each quart of skim-milk. Scarcely any of the calves appeared to be able to take more than this amount per quart without disturbing their digestion. When one and a half ounces per quart were fed indigestion nearly always resulted, and the manure voided contained an excessive amount of fat, fatty acids and similar substances. During the last few weeks of the calf's life one and a quarter ounces were fed for each quart of the skim-milk.

Other Oils substituted.

Only one-half ounce of either cotton-seed or corn oil could be fed per quart of milk without producing bad effects. One calf was fed with one-half ounce of "oleo" and one-half ounce of cotton-seed oil per quart of milk. Another was fed with one-half ounce of "oleo" and two ounces of brown sugar per quart of skim-milk.

Following comes the financial record of the seven calves. Five were fed skim-milk and "oleo," one skim-milk and cotton-seed and corn oils, and one skim-milk, "oleo" and brown sugar.

Financial Results.

Calf 1.

Age when received: three days.

Breed: Jersey, bull.

Foods fed: whole milk for the first four days, and then gradually changing to skim-milk mixed with oleomargarine.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	–
23.00 quarts whole milk, at 3 cents,	69	–
23.83 pounds "oleo," at 10½ cents,	2 50	–
134.00 pounds live weight, at 5 cents,	–	$6 70
332.00 quarts skim-milk returned,	2 51	–
	$6 70	$6 70

Price returned per quart for skim-milk fed, ... 0.76 cents.

Calf 2.

Age when received: two days.
Breed: Jersey, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	–
45.00 quarts whole milk, at 3 cents,	1 35	–
34.70 pounds "oleo," at 10½ cents,	3 64	–
91.00 pounds dressed weight, at 7 cents,	–	$6 37
446.00 quarts skim-milk returned,	38	–
	$6 37	$6 37

Price returned per quart for skim-milk fed, . . . 0.08 of a cent.

Calf 3.

Age when received: three days.
Breed: grade Durham, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	–
75.50 quarts whole milk, at 3 cents,	2 27	–
36.33 pounds "oleo," at 10½ cents,	3 81	–
86.00 pounds dressed weight, at 7½ cents,	–	$6 45
521.00 quarts skim-milk returned,	–	—0 63
	$7 08	$7 08

Calf 4.

Age when received: three days.
Breed: grade Ayrshire, heifer.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
75.50 quarts whole milk, at 3 cents, . . .	2 27	–
33.24 pounds "oleo," at 10½ cents, . . .	3 49	–
86.50 pounds dressed weight, at 7½ cents, .	–	$6 48
474.00 quarts skim-milk returned, . . .	–	—0 28
	$6 76	$6 76

Calf 5.

Age when received: seven days.
Breed: grade Holstein, bull.

Foods fed: whole milk first five days, and then gradually changed to skim-milk mixed with oleomargarine, cotton-seed and corn oils.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
50.00 quarts whole milk, at 3 cents, . . .	1 50	–
5.38 pounds "oleo," at 10½ cents, . . .	56	–
224.00 ounces cotton-seed oil, at 8 cents, . .	1 79	–
42.00 ounces corn oil, at 8 cents, . . .	34	–
152.00 pounds live weight, at 4 cents, . .	–	$6 08
442.50 quarts skim-milk returned, . . .	89	–
	$6 08	$6 08

Price returned per quart for skim-milk fed, . . . 0.20 of a cent.

Calf 6.

Age when received: ten days.
Breed: grade Holstein, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
50.00 quarts whole milk, at 3 cents, . . .	1 50	–
25.81 pounds "oleo," at 10½ cents, . .	2 71	–
73.00 pounds dressed weight, at 8 cents, . .	–	$5 84
303.00 quarts skim-milk returned, . . .	63	–
	$5 84	$5 84

Price returned per quart for skim-milk fed, . . . 0.21 of a cent.

Calf 7.

Age when received: three days.
Breed: grade Durham, bull.

Foods fed: whole milk for first five days, then skim-milk mixed with different amounts of tallow, oleomargarine and brown sugar.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
42.00 quarts whole milk, at 3 cents, . . .	1 26	–
6.69 pounds jacket tallow, at 6 cents,* .	40	–
8.50 pounds "oleo," at 10½ cents, . . .	89	–
8.06 pounds sugar, at 4 cents, ...	32	–
153.50 pounds live weight, at 4½ cents, . .	–	$6 91
334.00 quarts skim-milk returned, . . .	3 04	–
	$6 91	$6 91

Price returned per quart for skim-milk fed, . . . 0.91 of a cent.

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* Jacket tallow was not satisfactory; it crystallized out rapidly from the emulsion, and was consequently only partially consumed.

General Conclusions.

	1893.	1894.
Average daily gain in live weight (pounds),	1.49	1.55
Dry matter required to produce one pound live weight (pounds),	1.77	1.67
Dry matter required to produce one pound dressed weight (pounds),	2.98	3.09
Shrinkage in dressing (per cent. ,	44.22	44.57
Average number of weeks fed,	10	7
Average weight of calves when sold (pounds),	177	150

The financial results of the experiment are not satisfactory. The average return for the skim-milk in case of the seven calves was but 0.28 of a cent per quart. Last year, when skim-milk alone was fed, a return of from 0.63 to 0.73 of a cent per quart was secured. Although the condition of these calves was superior to those grown on skim-milk alone, our local butcher refused to give much if any more, simply because they were not "suckers." Whole-milk veal being worth six cents, live weight, these calves were certainly worth five cents, while from nearly all of them but from four to four and a half cents could be obtained. If five cents per pound live weight had been obtained the financial showing would have been better, but even then not satisfactory. The condition of the calves fed on artificial milk was, as above mentioned, much more satisfactory than those fed on the skim-milk. They were not, however, equal in fatness to sucking calves.

Calf 1 was in a very fair condition. The kidneys were quite well covered with fat. Calves 3 and 4 were equal to No. 1. Calf 5 was fed partly on cotton-seed oil as a source of fat. When the oil was first fed the calf seemed to improve in condition, and his coat took on a glossy appearance; but continued feeding of the oil did not appear to be favorable, and when slaughtered his carcass contained very little fat. Calf 7, fed on skim-milk with one part "oleo" to two parts brown sugar as cream substitute, gave by far the best results. He grew rapidly, making an average daily gain of 2.04 pounds, and he returned 0.91 of a cent per quart for the skim-milk fed. His kidneys were quite well covered with fat.

It is intended to note the effect of this mixture on other calves. It must be admitted that considerable labor is required to feed calves as described, and when pork brings from six and a half to seven cents per pound dressed weight it will undoubtedly be more profitable to feed the skim-milk to pigs. The average farmer would not find it profitable to attempt to fatten veal calves by this method.

If the mixture of skim-milk, "oleo" and brown sugar or skim-milk and brown sugar gives approximately as good results with the average calf as it did in case of calf 7 of the present experiment, fatting veal by this process might prove profitable to a limited number when circumstances were favorable.

When pork is below six and a half cents per pound, dressed weight, it would undoubtedly be profitable to feed the skim-milk alone to calves after they are a week old, provided they will bring four cents per pound live weight. When eight to nine weeks old they will weigh about 160 pounds.

Skim-milk can also be fed with decided profit to calves that are intended to be raised to maturity upon the farm. As soon as the animals are old enough to consume grain in addition to the milk, equal parts of Buffalo gluten feed and corn meal or cream gluten meal and corn meal can be fed dry.

TABLES SHOWING AVERAGE DAILY FOOD CONSUMPTION AND GAIN IN LIVE WEIGHT.

Calf 1.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
May 5–7,	66.75	4.33	0.33	0.02
14,	78.50	1.43	5.43	0.36
21,	87.00	–	7.43	0.47
28,	99.00	–	9.00	0.50
June 4,	114.00	–	10.43	0.68
11,	130.25	–	11.57	0.97
13,	134.00	–	12.00	1.05
Average daily gain,	1.68	–	–	–

Calf 2.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
May 5–7,	68.75	4.33	–	–
14,	74.50	3.43	1.29	0.11
21,	87.00	1.14	5.86	0.40
28,	97.50	–	8.86	0.50
June 4,	115.00	–	10.43	0.68
11,	130.25	–	11.57	0.97
18,	144.00	–	12.00	1.05
25,	157.00	–	12.00	1.05
26,	156.00	–	12.00	1.05
Average daily gain,	1.65	–	–	–

Calf 3.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
June 13,	60.50	6.00	–	–
18,	70.00	6.00	–	–
25,	79.50	2.57	3.43	0.22
July 2,	80.00	0.29	5.86	0.38
9,	92.00	–	8.14	0.53
16,	105.00	–	9.57	0.63
23,	119.50	–	10.14	0.66
30,	137.50	–	11.14	0.73
Aug. 6,	146.50	2.79	9.43	0.31
15,	153.00	–	13.00	0.99
Average daily gain,	1.45	–	–	–

Calf 4.

June 18,	75.00	4.00	–	–
25,	75.00	4.71	–	–
July 2,	82.25	3.29	2.29	0.15
9,	94.00	–	8.43	0.56
16,	105.00	–	9.57	0.63
23,	121.25	–	10.14	0.66
30,	136.50	–	11.14	0.73
Aug. 6,	142.50	2.79	9.43	0.31
13,	157.75	–	13.00	0.99
15,	156.00	–	13.00	0.99
Average daily gain,	1.37	–	–	–

Calf 5.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Ounces).	Corn Oil (Ounces).
Aug. 14, . .	71.00	3.00	–	–	–	–
22, . .	83.50	5.13	0.75	0.05	–	–
28, . .	94.25	1.00	6.00	0.38	–	–
Sept. 4, . .	102.00	–	8.14	0.29	3.57	–
10, .	118.00	–	9.00	0.13	7.00	–
18, . .	123.50	–	9.25	–	5.63	–
24, . .	130.50	–	9.75	–	7.17	0.50
Oct. 1, . .	137.50	–	9.00	–	3.86	3.00
8, . .	148.50	–	8.57	–	3.43	2.57
11, . .	152.00	–	12.00	–	6.00	–
Av. daily gain,	1.37	–	–	–	–	–

Calf 6.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
Aug. 14, ...	87.00	3.00	–	–
22, ...	98.50	5.13	0.75	0.05
28, ...	109.00	1.00	6.00	0.38
Sept. 4, ...	115.00	–	8.14	0.73
10, ...	122.50	–	9.00	0.84
17, ...	131.50	–	9.57	0.90
24, ...	138.50	–	9.86	0.88
26, ...	144.00	–	11.00	0.69
Average daily gain, .	1.30	–	–	–

Calf 7.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).
Sept. 4, . .	70.00	–	–	–	–	–
10, . .	77.00	5.00	–	–	–	–
17, . .	87.00	1.71	4.57	0.29	–	–
24, . .	98.00	–	8.14	0.51	–	–
Oct. 1, . .	118.00	–	9.86	0.16	0.41	0.05
8, . .	137.50	–	11.14	–	0.38	0.47
15, . .	153.50	–	12.14	–	0.38	0.59
Av. daily gain,	2.04	–	–	–	–	–

TABLES GIVING DETAILED RECORD OF EACH CALF.

Calf 1.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	23.00	154.00	10.00	1 : 4	66.75	99.00	1.34	7.53
II.	May 29 to June 13,	-	178.00	13.83	1 : 4.4	99.00	134.00	2.20	6.43

Total Amount of Feed consumed from May 5 to June 13, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
23.00 quarts whole milk, ...	6.83	$0 69	$0 04
332.00 quarts skim-milk, ...	69.34	1 49	49
23.83 pounds "oleo,"	23.83	2 50	-
	100.00	$4 68	$0 53

Live weight of the animal at the beginning of the experiment,	66.75 lbs.
Live weight of the animal at the end of the experiment, .	134.00 "
Live weight gained during the experiment, ...	67.25 "
Dressed weight of the animal, ...	74.00 "
Loss in weight by dressing, 44.78 per cent., ...	60.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.29 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.69 "
Total cost of feed per pound of live weight gained, . .	6.95 cts.
Net cost of feed per pound of live weight gained, . .	6.17 "

Calf 2.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	45.00	112.00	7.50	1:4.25	68.75	97.50	1.20	9.19
II.	May 29 to June 11,	-	154.00	11.60	1:4.2	97.50	130.25	2.34	5.84
III.	June 12 to June 26,	-	180.00	15.60	1:4.6	130.25	156.00	1.72	9.51

Total Amount of Feed consumed from May 5 to June 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
45.00 quarts whole milk, ...	13.37	$1 35	$0 07
446.00 quarts skim-milk, ...	93.14	2 01	66
34.70 pounds "oleo,"	34.70	3 64	-
	141.21	$7 00	$0 73

Live weight of the animal at the beginning of the experiment,	68.75 lbs.
Live weight of the animal at the end of the experiment, .	156.00 "
Live weight gained during the experiment, . . .	87.25 "
Dressed weight of the animal, ...	91.00 "
Loss in weight by dressing, 41.67 per cent., . . .	65.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.62 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.77 "
Total cost of feed per pound of live weight gained, . .	8.02 cts.
Net cost of feed per pound of live weight gained, . .	7.19 "

Calf 3.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 13 to July 9,	56.00	122.00	8.01	1:4.2	60.50	92.00	1.17	9.75
II.	July 10 to July 23,	–	138.00	9.06	1:4.1	92.00	119.50	1.96	5.72
III.	July 24 to Aug. 15,	19.50	261.00	19.26	1:4.3	119.50	153.00	1.46	11.29

Total Amount of Feed consumed from June 13 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk, ...	22.43	$2 27	$0 12
521.00 quarts skim-milk, ...	109.77	2 34	77
36.33 pounds "oleo,"	36.33	3 81	–
	168.53	$8 42	$0 89

Live weight of the animal at the beginning of the experiment,	60.50 lbs.
Live weight of the animal at the end of the experiment, .	153.00 "
Live weight gained during the experiment, . . .	92.50 "
Dressed weight of the animal, ...	86.00 "
Loss in weight by dressing, 43.79 per cent., . . .	67.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.24 "
Total cost of feed per pound of live weight gained, . .	9.10 cts.
Net cost of feed per pound of live weight gained, . .	8.14 "

Calf 4.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 18 to July 16,	56.00	142.00	9.32	1:4.2	75.00	105.00	1.03	10.99
II.	July 17 to July 30,	-	149.00	9.78	1:4.1	105.00	136.50	2.25	5.39
III.	July 31 to Aug. 15,	19.50	183.00	14.14	1:4.4	136.50	156.00	1.22	14.82

Total Amount of Feed consumed from June 18 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk, ...	22.43	$2 27	$0 12
474.00 quarts skim-milk, ...	98.99	2 13	70
33.24 pounds "oleo,"	33.24	3 49	–
	154.66	$7 89	$0 82

Live weight of the animal at the beginning of the experiment,	75.00 lbs.
Live weight of the animal at the end of the experiment, .	156.00 "
Live weight gained during the experiment, . . .	81.00 "
Dressed weight of the animal, ...	86.50 "
Loss in weight by dressing, 44.55 per cent., . . .	69.50 "
Pounds of dry matter to produce 1 pound of live weight, .	1.91 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.44 "
Total cost of feed per pound of live weight gained, . .	9.74 cts.
Net cost of feed per pound of live weight gained, . .	8.73 "

Calf 5.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Pounds).	Corn Oil Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Sept. 4,	50.00	99.00	4.63	1.56	-	1:4	71.00	102.00	1.41	8.49
II.	Sept. 5 to Sept. 18,	-	128.00	0.75	5.44	-		102.00	123.50	1.54	6.28
III.	Sept. 19 to Oct. 11,	-	215.50	-	7.00	2.62		123.50	152.00	1.24	7.72

Total Amount of Feed consumed from Aug. 14 to Oct. 11, 1894

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk,	14.86	$1 50	$0 08
442.50 quarts skim-milk,	92.41	1 99	65
5.38 pounds "oleo,"	5.38	56	-
224.00 ounces cotton-seed oil,	14.00	1 79	-
42.00 ounces corn oil,	2.63	34	-
	129.28	$6 18	$0 73

Live weight of the animal at the beginning of the experiment,	71.00 lbs.
Live weight of the animal at the end of the experiment,	152.00 "
Live weight gained during the experiment,	81.00 "
Dressed weight of the animal,	-
Loss in weight by dressing, per cent.,	-
Pounds of dry matter to produce 1 pound of live weight,	1.60 "
Pounds of dry matter to produce 1 pound of dressed weight,	-
Total cost of feed per pound of live weight gained,	7.63 cts.
Net cost of feed per pound of live weight gained,	6.73 "

Calf 6.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	Cotton-seed Oil (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Aug. 22,	44.00	6.00	0.37	1:4 to 1:4.5	87.00	98.50	1.28	12.04
II.	Aug. 23 to Sept. 10,	6.00	147.00	12.41		98.50	122.50	1.26	8.93
III.	Sept. 11 to Sept. 26,	-	150.00	13.03		122.50	144.00	1.34	9.50

Total Amount of Feed consumed from Aug. 14 to Sept. 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk, ...	14.86	$1 50	$0 08
303.00 quarts skim-milk, ...	63.28	1 36	45
25.81 pounds "oleo,"	25.81	2 71	-
	103.95	$5 57	$0 53

Live weight of the animal at the beginning of the experiment,	87.00 lbs.
Live weight of the animal at the end of the experiment, .	144.00 "
Live weight gained during the experiment, ...	57.00 "
Dressed weight of the animal, ...	73.00 "
Loss in weight by dressing, 49.31 per cent., . . .	71.00 "
Pounds of dry matter to produce 1 pound of live weight,	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.51 "
Total cost of feed per pound of live weight gained, . .	9.77 cts.
Net cost of feed per pound of live weight gained, . .	8.84 "

Calf 7.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Sept. 4 to Sept. 24,	42.00	89.00	5.56	–	–	1:3.5 to 1:4	70.00	98.00	1.33	7.12
II.	Sept. 25 to Oct. 1,	–	69.00	1.13	2.88	0.37		98.00	118.00	2.86	3.48
III.	Oct. 2 to Oct. 16,	–	176.00	–	5.62	7.69		118.00	153.50	2.33	4.70

Total Amount of Feed consumed from Sept. 4 to Oct. 16, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
42.00 quarts whole milk,	12.47	$1 26	$0 06
334.00 quarts skim-milk,	69.75	1 50	49
6.69 pounds jacket tallow,	6.69	40	–
8.50 pounds "oleo,"	8.50	89	–
8.06 pounds sugar,	8.06	32	–
	105.47	$4 37	$0 53

Live weight of the animal at the beginning of the experiment,	70.00 lbs.
Live weight of the animal at the end of the experiment,	153.50 "
Live weight gained during the experiment,	63.50 "
Dressed weight of the animal,	87.00 "
Loss in weight by dressing, 43.32 per cent.,	66.50 "
Pounds of dry matter to produce 1 pound of live weight,	1.66 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.93 "
Total cost of feed per pound of live weight gained,	6.88 cts.
Net cost of feed per pound of live weight gained,	6.05 "

Average Analyses of Milks.

FODDER ANALYSES	Skim-milk.	Whole Milk.
Moisture at 100° C.,	90.42	86.18
Dry matter,	9.58	13.82
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.14	5.35
" cellulose,	-	-
" fat,	2.61	33.43
" protein,	35.23	25.33
Non-nitrogenous extract matter,	54.02	35.89
	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Skim-milk.	Whole Milk.
Moisture,	90.42	86.18
Nitrogen,	0.52	0.56
Phosphoric acid,	0.18	0.19
Potassium oxide,	0.19	0.17
Value per 2,000 pounds,	$1 93	$2 04
Manurial value obtainable,*	1 35	1 43

* Allowing thirty per cent. of the fertilizing constituents to be retained in the system of the growing animal.

Local Market Value of the Various Foods.

Whole milk (per gallon),	12.0 cts.
Skim-milk (per gallon),	1.8 "
Cotton-seed oil (per gallon),	$1 00
Corn oil (per gallon),	1 00
Oleomargarine (per pound),	10.5 cts.
Jacket tallow (per pound),	5.5 "
Brown sugar (per pound),	4.0 "

VIII.

DIGESTION EXPERIMENTS.

1. DIGESTION EXPERIMENTS WITH SHEEP.

By J. B. Lindsey, R. H. Smith and E. B. Holland.

During the past year we have continued the study of the digestibility of the concentrated by-products so freely offered for sale in our eastern markets. Especial attention has been given to the gluten feeds and meals. The results obtained with the gluten feeds are not as yet decisive. The coefficients of digestibility, in case of different samples of these feeds, appear to vary considerably. Whether this is caused by the method of preparation is not as yet clear. Additional tests will be made.

Value of Digestion Experiments.

1. A food is valuable as a source of nourishment only in so far as its various constituents can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder.

For one to form an intelligent opinion as to the value of different fodder stuffs, the amount of digestible matter they contain must be known.

2. In order to combine the different fodder stuffs so as to obtain properly balanced rations for our farm stock, one should know the percentages of the different digestible constituents contained in each of the several foods.

THE EXCRETA OF AN ANIMAL, — WHAT THEY ARE.

The fæces are nothing more than the undigested portions of the food. They are the portions that have resisted the action of the various secretions of the stomach and digestive fluids and bacteria of the intestines, and are consequently excreted by the animal as so much worthless material. The urine is entirely distinct from the fæces. It contains the water and the end products of the digestion of the nitrogenous portion of the food, — the urea and hippuric acid, — which have been removed from the blood by the kidneys. It also contains about one-third of the phosphoric acid and nearly all of the alkalies of the food consumed that have not been retained in the animal's system, and small quantities of other materials that it is unnecessary to consider in this connection.

HOW THE DIGESTIBLE MATTER OF A FOOD IS DETERMINED.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams).
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.69
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

METHODS EMPLOYED.

Four sheep were used. Nos. 1 and 2 were four years old, and Nos. 3 and 4 two years. The full details of the method will be found fully described in the eleventh report of this station, 1893.

FEEDS TESTED.

Hay of Mixed Grasses.

The hay is a fair average of that grown upon the station grounds. It was harvested the latter part of June, when the various grasses were in blossom. The grasses of which it was composed were principally herds grass, red top, Kentucky blue grass, meadow fescue, sweet-scented vernal grass, together with a fair sprinkling of clover. It was fed alone, and as a coarse fodder in combination with the different grains tested.

Vetch and Oats.

The vetch and oats are fed by us as a substitute for hay. They were sown at the rate of 4 bushels of oats and 40 pounds of vetch per acre about the middle of April. These were cut in late blossom, and made into hay. If cut in early bloom they would probably prove somewhat more digestible.

New-process Linseed Meal.

Linseed meal is the flaxseed remaining after the oil has been removed. In case of the new-process meal the oil is extracted by naphtha or some similar solvent, and is in consequence more thoroughly removed than by pressure.

Buffalo Gluten Feed.

This is a by-product in the manufacture of starch from corn. The starch is separated from the yellow or albuminous part of the grain by means of water. The hulls and germs are separated by screening. After the starch is removed the yellow or flinty portion is mixed with the germs and hulls. The mixture is kiln-dried and partially ground.

Peoria Gluten Feed.

Similar in appearance to the Buffalo, but the sample tested was rather inferior in composition. It is probably prepared from corn, in much the same way as the Buffalo gluten feed.

Chicago Maize Feed.

This feed is also prepared from corn. It is said to be a mixture of the yellow albuminous portion and the hulls without the germ. It contains, therefore, somewhat less fat than the gluten feeds. The hulls are not ground quite as fine.

Chicago Gluten Meal.

This is the yellow albuminous portion of the corn kernel. It contains much less fat than the other gluten meals. It was in good mechanical condition, and quite dry.

King Gluten Meal.

This meal was ground very fine. It contained a very high percentage of fat (19 per cent.).

Atlas Meal.

This is a by-product obtained from corn or grain in the process of the manufacture of alcohol. The starch of the grain is converted into sugar by the action of diastase, and finally into alcohol by fermentation. The hull, gluten and germ are left behind. The meal is probably composed of these, together with an admixture of malt sprouts. It is rich in fat and albuminoids. It is made by the Atlas Distilling Company, Peoria, Ill.

Peanut Feed.

This material appears to be peanut shells finely ground, with a small admixture of the nut. It contained over 50 per cent. of cellulose.

Soja-bean Meal.

The beans were raised upon the grounds of the Hatch Experiment Station. The quantity necessary for the experiment was supplied through the kindness of Professor Brooks.

Rye Meal.

The rye was raised upon the station grounds, and was of good average quality.

Winter Wheat Bran.

A fair sample of genuine winter bran.

RESULTS OF THE EXPERIMENT.

Digestibility of the Foods.

	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of mixed grasses (*a*),	1	4	59	62	50	58	59
Hay of mixed grasses (*d*),	1	3	55	57	47	58	57
Average of both samples,	2	7	57	60	49	58	58
Vetch and oats,	1	2	58	66	19	60	54
New-process linseed meal,	1	2	77	99	102?	83	87
Buffalo gluten feed,	1	2	90	100	94	89	89
Peoria gluten feed,	1	2	86	78	79	83	90
Chicago maize feed,	1	2	87	82	92	85	88
Chicago gluten meal,	1	2	93	22	97	91	97
King gluten meal,	1	2	85	–	95	92	84
Atlas meal,	1	2	80	106?	91	73	84
Peanut feed,	1	2	32	12	90	71	49
Soja-bean meal,	1	2	82	71	86	91	76
Rye meal,	1	2	87	–	64	84	92
Winter wheat bran,	1	2	62	14	67	78	72

COMMENTS ON THE RESULTS.

Hays.

The hays prove to be about as digestible as those tested a year ago, and correspond in digestibility very closely to the figures given by Wolff.

Vetch and Oats.

The vetch and oats hay appears, with the exception of the fat, to be about as digestible as good English hay.

New-process Linseed Meal.

This test corresponds fairly with those made a year ago. The animal appeared to have very thoroughly assimilated the fat of the meal.

Buffalo Gluten Feed.

This sample gives distinctly higher digestion percentages than the one tested a year ago. The reason for this cannot be given. The parallel tests in each case agree closely. Other samples will be procured and further tests made.

Peoria Gluten and Chicago Maize Feeds.

These two gluten feeds correspond very closely one with the other in the amounts of digestible matter they contain. The Peoria feed was inferior in composition to the maize feed.

Chicago Gluten Meal.

As there is comparatively no cellulose in this and the King gluten meal, that ingredient is not to be considered. The Chicago meal shows an exceptional degree of digestibility, 93 per cent. of the entire meal having been assimilated.

King Gluten Meal.

The King gluten meal was also quite digestible, 85 per cent. of the total dry matter being assimilated.

Atlas Meal.

This meal has 80 per cent. of digestible matter. The protein is about 73 per cent. digestible. It is somewhat inferior to the gluten meals in digestibility, although, with the exception of the increased percentage of cellulose present, it resembles them in composition. The cellulose appears in this test to have been all digested. This meal is a valuable addition to our feed-stuff supply, if it can be bought at a reasonable price. Additional digestion tests will be made.

Peanut Feed.

This material is unquestionably of inferior feeding value. Its dry matter was but 32 per cent. digestible, and it contained 54 per cent. of cellulose, of which but 12 per cent. were digested. The fat and protein were quite well assimilated, but the percentages contained — especially that of the protein — were comparatively small. The extract matter was only 49 per cent. digestible.

Soja-bean Meal.

The test of this meal was not entirely satisfactory, the variations in the percentages of cellulose and fat digestible in case of the two sheep being too large. Wolff gives the results of but two single trials with this meal, which correspond fairly with the figures found in our trial.

Rye Meal.

Wolff gives no direct digestion coefficients for rye. Our results make it appear practically as digestible as the corn meal, the protein even more so.

Winter Wheat Bran.

The digestibility of this bran is practically the same as the spring bran reported last year. As these two brans appear to have also the same percentage composition, they should be worth the same price per ton. Different seasons might exert some influence on composition and digestibility.

DETAILS OF THE EXPERIMENT.

Dry Matter Determinations made at the Time of Weighing out the Different Foods, and Dry Matter in Manure excreted.

SHEEP I.

PERIODS.	Hay.	New-process Linseed Meal.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Rye Meal.	Winter Wheat Bran.	Waste.	Manure.
I.,	88.48	–	–	–	–	–	–	84.30	90.26
II.,	87.81	–	–	–	–	–	–	–	91.14
IV.,	85.99	89.39	–	–	–	–	–	–	92.98
VI.,	88.40	–	90.08	–	–	–	–	–	91.84
VIII.,	86.28	–	–	–	90.31	–	–	–	93.27
IX.,	86.49	–	–	91.62	–	–	–	–	91.77
XIII.,	87.19	–	–	–	–	85.74	–	–	94.95
XIV.,	86.31	–	–	–	–	–	86.29	–	93.25

SHEEP II.

I.,	88.48	–	–	–	–	–	–	–	89.58
II.,	87.81	–	–	–	–	–	–	–	91.33
VIII.,	86.28	–	–	–	90.31	–	–	–	93.14
IX.,	86.49	–	–	91.62	–	–	–	–	91.17
XIII.,	87.19	–	–	–	–	85.74	–	–	95.14
XIV.,	86.31	–	–	–	–	–	86.29	–	93.14

SHEEP III.

PERIODS.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I.,	88.48	–	–	–	–	–	–	–	85.40	91.00
II.,	88.40	–	–	–	–	–	–	–	–	91.91
III.,	–	85.12	–	–	–	–	–	–	–	91.71
V.,	86.28	–	91.86	–	–	–	–	–	–	93.48
VII.,	86.49	–	–	89.72	–	–	–	–	–	91.34
X.,	84.66	–	–	–	–	91.04	–	–	–	94.56
XI.,	87.85	–	–	–	–	–	90.43	–	–	94.31
XII.,	86.31	–	–	–	–	–	–	90.22	–	93.20

SHEEP IV.

PERIODS.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	-	-	93.08
II.,	88.40	-	-	-	-	-	-	-	-	92.04
III.,	-	85.12	-	-	-	-	-	-	-	90.73
V.,	86.28	-	91.86	-	-	-	-	-	-	93.20
VI.,	87.19	-	-	-	89.72	-	-	-	-	94.88
VII.,	86.49	-	-	89.72	-	-	-	-	-	91.49
X.,	84.66	-	-	-	-	91.04	-	-	-	94.46
XI.,	87.85	-	-	-	-	-	90.43	-	-	94.14
XII.,	86.31	-	-	-	-	-	-	90.22	-	93.20

Composition of Feed Stuffs.

[Dry Matter.]

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay (*a*),	7.09	32.09	3.23	11.17	46.42
Hay (*b*),	7.99	32.50	2.29	9.74	47.48
Hay (*c*),	7.28	33.43	2.54	9.74	47.01
Hay (*d*) (average *b* and *c*),	7.63	32.96	2.41	9.74	47.24
Vetch and oats,	10.65	35.95	2.61	13.42	37.37
Winter wheat bran,	7.59	10.64	4.97	15.61	61.19
Soja-bean meal,	6.20	4.50	18.89	38.47	31.94
New-process linseed meal,	6.02	8.04	4.30	41.38	40.26
Chicago maize feed,	0.80	9.06	9.00	26.13	55.01
Buffalo gluten feed,	0.40	8.46	13.32	22.93	54.89
Peoria gluten feed,	0.84	8.30	6.27	19.24	65.35
Chicago gluten meal,	0.14	1.73	4.60	37.09	56.44
King gluten meal,	1.50	1.41	19.68	38.57	38.84
Peanut feed,	5.06	54.40	5.54	12.06	22.94
Rye meal,	1.16	1.79	1.79	13.63	81.63
Atlas meal,	1.03	9.73	42.63	15.77	30.84
Waste, Sheep I.,	10.91	30.88	3.42	12.21	42.58
Waste, Sheep III.,	9.95	32.16	3.10	11.37	43.42

Composition of Fæces.

[Dry Matter.]

Sheep I.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.01	29.92	3.89	11.21	45.97
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.41	28.19	4.61	10.57	45.22
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	9.01	28.41	3.86	13.84	44.88
Period IX.					
Hay (*a*) and King gluten meal, .	9.50	27.28	4.73	12.68	45.81
Period IV.					
Hay (*a*) and new-process linseed meal, ...	10.00	29.78	3.26	14.50	42.46
Period II.					
Hay (*b*), ...	11.40	31.34	2.65	9.06	45.55
Period VI.					
Hay (*d*) and Peoria gluten feed, .	10.75	29.88	3.47	10.94	44.96
Period XIII.					
Hay (*d*) and rye meal, . . .	11.08	30.05	3.20	10.44	45.23

Sheep II.

Period I.					
Hay (*a*), ...	8.37	29.96	3.75	11.54	46.38
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.78	27.33	3.58	10.73	46.58
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	8.86	29.28	3.84	12.94	45.08
Period IX.					
Hay (*a*) and King gluten meal, .	9.06	29.21	3.87	12.19	45.67
Period II.					
Hay (*b*), ...	11.92	30.40	2.57	10.18	44.93
Period XIII.					
Hay (*d*) and rye meal, . . .	10.24	29.49	3.10	9.72	47.45

SHEEP III.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.)	Extract Matter (Per Cent.).
Period I. Hay (*a*),	9.30	28.94	4.35	11.75	45.66
Period XII. Hay (*a*) and soja-bean meal,	11.21	25.89	6.26	12.54	44.10
Period V. Hay (*a*) and Buffalo gluten feed,	8.76	26.81	4.50	12.72	47.21
Period VII. Hay (*a*) and Chicago maize feed,	8.26	27.29	4.29	13.81	46.35
Period III. Vetch and oats,	11.81	29.88	5.18	12.51	40.62
Period II. Hay (*c*),	10.67	31.53	3.07	9.18	45.55
Period XI. Hay (*d*) and peanut feed,	9.70	49.96	1.92	7.25	31.17
Period X. Hay (*d*) and atlas meal,	11.39	27.49	3.24	15.21	42.67

SHEEP IV.

Period I. Hay (*a*),	9.23	28.96	3.89	10.90	47.02
Period XII. Hay (*a*) and soja-bean meal,	9.77	25.76	5.17	12.61	46.69
Period V. Hay (*a*) and Buffalo gluten feed,	8.85	26.47	4.20	12.89	47.59
Period VII. Hay (*a*) and Chicago maize feed,	7.87	27.48	4.13	13.31	47.21
Period III. Vetch and oats,	12.12	28.43	4.96	13.31	41.18
Period II. Hay (*c*),	11.93	31.26	2.99	8.94	44.88
Period XI. Hay (*d*) and peanut feed,	8.07	48.75	1.95	7.37	33.86
Period VI. Hay (*d*) and Peoria gluten feed,	11.45	28.04	3.84	10.60	46.07
Period X. Hay (*d*) and atlas meal,	12.32	26.21	3.49	15.38	42.60

Tables showing Food fed and Water drank Daily, the Daily Amount of Manure excreted and the Temperature of the Stables.

PERIOD I.

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29, .	37.0	874	34.06	2,035	926	33.30	2,002
30, .	44.0	865	37.78	2,068	1,010	48.08	1,780
31, .	35.5	805	31.30	2,055	989	37.86	1,542
April 1, .	54.5	833	34.06	2,128	1,040	36.76	1,860
2, .	46.0	819	30.58	2,202	903	34.60	1,490
3, .	37.5	908	39.99	2,167	834	34.55	1,570
4, .	41.5	808	32.13	2,047	812	32.93	1,610
Averages, .	42.3	845	34.27	2,100	931	36.87	1,693

* One-tenth preserved as daily sample in all cases except Period IV.

Weight of Sheep I. at beginning of period, . . .	115.00 lbs.
Weight of Sheep II. at beginning of period, . . .	117.00 "
Weight of Sheep I. at end of period, ...	114.50 "
Weight of Sheep II. at end of period, ...	117.50 "

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29, .	37.0	823	31.55	1,935	687	33.71	1,415
30, .	44.0	890	37.04	2,258	621	31.44	1,694
31, .	35.5	909	33.00	1,682	690	33.07	1,263
April 1, .	54.5	1,158	39.31	1,319	739	35.37	1,609
2, .	46.0	897	31.97	1,428	709	34.47	1,990
3, .	37.5	791	32.75	1,670	642	29.83	1,159
4, .	41.5	733	30.45	1,943	680	32.35	1,690
Averages, .	42.3	886	33.72	1,748	681	32.89	1,546

Weight of Sheep III. at beginning of period, . . .	115.25 lbs.
Weight of Sheep IV. at beginning of period, . . .	115.75 "
Weight of Sheep III. at end of period, ...	118.50 "
Weight of Sheep IV. at end of period, ...	117.25 "

PERIOD II.

[Food consumed daily: 900 grams hay (*b*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 27, .	58.0	900	36.93	1,685	1,176	41.69	1,693
28, .	64.0	933	40.81	1,861	1,182	40.84	1,749
29, .	69.5	914	39.00	1,838	1,037	36.10	1,531
30, .	62.0	998	43.41	2,208	-	-	-
October 1, .	-	903	37.28	1,353	-	-	-
2, .	59.5	982	41.55	2,078	-	-	-
3, .	-	1,003	40.85	1,645	-	-	-
Averages, .	62.6	948	39.98	1,810	1,132	39.54	1,658

Weight of Sheep I. at beginning of period, ... 116.50 lbs.
Weight of Sheep II. at beginning of period, ... 114.00 "
Weight of Sheep I. at end of period, ... 116.50 "
Weight of Sheep II. at end of period, ... -* "

* Not determined.

[Food consumed daily: 900 grams hay (*c*) and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 7, .	58.0	804	39.75	1,090	998	39.86	1,685
8, .	57.0	814	39.39	950	1,134	39.16	1,543
9, .	62.5	753	37.48	1,325	1,003	38.88	1,402
10, .	52.5	806	40.56	1,193	909	37.26	2,202
11, .	55.0	880	41.37	1,175	1,081	37.82	468
12, .	57.5	740	36.15	1,063	813	36.57	1,951
13, .	51.0	812	39.73	1,200	778	35.53	1,787
Averages, .	56.2	801	39.20	1,142	959	37.87	1,577

Weight of Sheep III. at beginning of period, ... 118.75 lbs.
Weight of Sheep IV. at beginning of period, ... 116.50 "
Weight of Sheep III. at end of period, ... 118.00 "
Weight of Sheep IV. at end of period, ... 116.50 "

PERIOD III.

[Food consumed daily: 900 grams vetch and oats and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 23, .	64.0	842	30.84	2,115	1,003	33.58	2,325
24, .	64.0	903	34.65	2,435	1,086	39.97	2,500
25, .	61.0	1,262	41.04	2,500	966	34.04	2,500
26, .	57.0	1,311	35.93	2,500	1,018	35.30	2,500
27, .	58.0	1,061	36.36	3,160	1,049	34.48	3,483
28, .	64.0	1,046	37.52	2,062	1,018	34.32	2,063
29, .	62.0	1,029	38.83	1,538	1,017	35.69	2,321
Averages, .	61.4	1,065	37.88	2,330	1,022	35.34	2,527

Weight of Sheep III. at beginning of period, ... 119.50 lbs.
Weight of Sheep IV. at beginning of period, ... 118.50 "
Weight of Sheep III. at end of period, ... 119.00 "
Weight of Sheep IV. at end of period, ... 117.00 "

PERIOD IV.

[Food consumed daily: 600 grams hay (*a*), 200 grams new-process linseed meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.
May 31, ...	56.5	567	58.80	2,358
June 1, ...	62.0	536	49.43	2,500
2, ...	57.5	680	62.82	1,700
3, ...	64.0	562	49.30	1,388
4, ...	70.0	583	52.35	2,450
5, ...	59.5	679	56.59	2,455
6, ...	56.0	558	50.12	1,935
Averages, ...	60.8	595	54.20	2,112

* One-fifth of total amount excreted preserved as daily sample; in all other periods one-tenth preserved.

Weight of animal at beginning of period, ... 117.00 lbs.
Weight of animal at end of period, ... 115.75 "

PERIOD V.

[Food consumed daily: 600 grams hay (*a*), 250 grams Buffalo gluten feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 2, . .	76.5	544	24.67	2,077	572	25.82	2,013
3, . .	70.0	519	24.28	1,865	521	23.05	2,337
4, . .	61.5	588	25.29	1,928	471	22.36	2,093
5, . .	55.0	647	28.06	1,588	598	27.84	1,865
6, . .	70.0	624	27.08	1,829	511	24.44	2,078
7, . .	71.5	535	23.67	1,938	511	23.99	1,372
8, . .	–	600	24.13	1,961	565	27.11	1,754
Averages, .	67.4	580	25.31	1,884	536	24.94	1,930

Weight of Sheep III. at beginning of period, . . . 115.75 lbs.
Weight of Sheep IV. at beginning of period, . . . 116.50 "
Weight of Sheep III. at end of period, ... 115.00 "
Weight of Sheep IV. at end of period, ... 115.50 "

PERIOD VI.

[Food consumed daily by Sheep I.: 550 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt; food consumed daily by Sheep IV.: 600 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt.]

DATE.	SHEEP I.				SHEEP IV.*			
	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Degrees.	Grams.	Grams.	Grams.
October 12, .	56.5	534	22.10	1,638	–	–	–	–
13, .	51.0	641	26.51	1,080	36.5	569	26.61	943
14, .	54.0	649	25.73	1,105	41.5	600	28.00	632
15, .	48.5	768	33.69	2,100	48.0	628	28.59	647
16, .	48.0	730	30.05	1,840	44.0	497	24.23	1,181
17, .	55.5	694	28.07	892	39.0	607	25.81	1,625
18, .	51.0	655	28.18	1,687	39.0	844	33.10	825
19, .	–	–	–	–	–	850	28.79	1,133
Averages,	52.1	667	27.76	1,477	41.3	656	27.88	998

* The period for Sheep IV. occupied the dates November 13–19 inclusive.

Weight of Sheep I. at beginning of period, . . . 111.75 lbs.
Weight of Sheep IV. at beginning of period, . . . 113.50 "
Weight of Sheep I. at end of period, ... 113.50 "
Weight of Sheep IV. at end of period, ... 113.25 "

PERIOD VII.

[Food consumed daily: 600 grams hay (*a*), 250 grams Chicago maize feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15, . .	60.5	594	27.00	2,137	611	28.73	2,325
16, . .	58.0	573	26.21	2,114	507	23.24	2,441
17, . .	64.0	537	23.92	1,730	567	28.00	2,013
18, . .	65.0	613	28.46	1,770	523	25.93	1,330
19, . .	64.5	528	24.93	1,640	518	23.68	2,319
20, . .	63.0	351	15.76	1,784	586	27.31	1,507
21, . .	57.0	1,054	37.09	1,255	620	29.44	1,125
Averages, .	61.7	607	26.20	1,776	562	26.62	1,866

Weight of Sheep III. at beginning of period, . . . 117.00 lbs.
Weight of Sheep IV. at beginning of period, . . . 117.00 "
Weight of Sheep III. at end of period, ... 119.50 "
Weight of Sheep IV. at end of period, ... 120.00 "

PERIOD VIII.

[Food consumed daily: 650 grams hay (*a*), 200 grams Chicago gluten meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 1, . .	70.0	534	24.12	2,253	794	23.08	2,109
2, . .	76.5	642	26.72	2,457	820	26.74	2,426
3, . .	70.0	636	25.65	3,423	821	26.60	2,105
4, . .	61.5	658	26.51	2,160	727	25.37	1,864
5, . .	55.0	669	26.97	1,963	822	28.83	1,774
6, . .	70.0	777	29.15	2,352	684	24.39	1,915
7, . .	71.5	714	24.47	2,500	723	26.28	2,115
Averages, .	67.8	661	26.23	2,444	770	25.90	2,044

Weight of Sheep I. at beginning of period. . . . . 113.25 lbs.
Weight of Sheep II. at beginning of period, . . . 117.25 "
Weight of Sheep I. at end of period, ... 112.75 "
Weight of Sheep II. at end of period, ... 117.75 "

PERIOD IX.

[Food consumed daily: 650 grams hay (*a*), 200 grams King gluten meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15, . .	60.5	645	28.45	3,008	682	28.71	1,838
16, . .	58.0	647	30.42	3,721	675	32.47	2,167
17, . .	64.0	677	29.57	1,968	670	27.60	2,123
18, . .	65.0	499	21.20	2,500	789	29.35	2,065
19, . .	64.5	653	28.27	2,406	673	26.47	1,869
20, . .	63.0	590	26.67	2,218	710	25.86	1,952
21, . .	57.0	657	29.26	2,252	810	28.93	2,016
Averages, .	61.7	624	27.69	2,582	716	28.48	2,004

Weight of Sheep I. at beginning of period, ... 114.75 lbs.
Weight of Sheep II at beginning of period, . . . 118.00 "
Weight of Sheep I. at end of period, ... 116.50 "
Weight of Sheep II. at end of period, ... 119.25 "

PERIOD X.

[Food consumed daily: 650 grams hay (*d*), 200 grams atlas meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
December 1, .	32.0	610	34.89	57	994	33.00	1,103
2, .	-	526	25.87	2,264	754	29.19	1,758
3, .	41.0	606	30.06	968	671	24.72	936
4, .	33.0	684	32.16	897	856	35.23	1,597
5, .	31.5	635	30.22	873	747	33.49	730
6, .	27.0	626	28.91	690	556	26.00	1,372
7, .	33.0	692	29.05	1,397	624	29.22	1,292
Averages, .	32.9	626	30.17	1,021	743	30.12	1,255

Weight of Sheep III. at beginning of period, . . . 117.00 lbs.
Weight of Sheep IV. at beginning of period, . . . 113.50 "
Weight of Sheep III. at end of period, ... 119.50 "
Weight of Sheep IV. at end of period, ... 117.50 "

PERIOD XI.

[Food consumed daily: 550 grams hay (*d*), 300 grams peanut feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 28, .	48.0	820	42.72	988	762	46.61	750
29, .	57.0	788	43.03	1,213	808	46.38	1,068
30, .	51.0	813	44.49	928	766	43.47	2,038
31, .	56.5	792	40.17	1,150	735	42.39	25
November 1, .	52.5	784	42.29	1,285	685	38.81	1,677
2, .	60.0	773	40.53	994	777	41.89	875
3, .	59.0	852	45.43	1,080	704	38.98	1,912
Averages, .	54.9	803	42.67	1,091	748	42.65	1,192

Weight of Sheep III. at beginning of period, . . . 114.50 lbs.
Weight of Sheep IV. at beginning of period, . . . 113.00 "
Weight of Sheep III. at end of period, ... 115.00 "
Weight of Sheep IV. at end of period, ... 113.00 "

PERIOD XII.

[Food consumed daily: 600 grams hay (*d*), 250 grams soja-bean meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	697	26.70	1,828	629	25.40	1,705
14, . .	50.0	727	34.55	1,669	649	25.09	2,133
15, . .	55.5	559	29.00	1,280	729	36.68	1,886
16, . .	56.0	577	24.20	1,645	596	24.42	1,530
17, . .	59.5	679	28.17	2,066	603	22.84	2,091
18, . .	58.0	583	24.25	1,187	634	22.92	2,255
19, . .	60.0	705	29.45	1,905	697	26.39	2,322
Averages, .	55.0	647	28.05	1,654	648	26.25	1,989

Weight of Sheep III. at beginning of period, . . . 114.00 lbs.
Weight of Sheep IV. at beginning of period, . . . 113.50 "
Weight of Sheep III. at end of period, ... 112.75 "
Weight of Sheep IV. at end of period, ... 114.00 "

PERIOD XIII.

[Food consumed daily: 550 grams hay (*d*), 300 grams rye meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
November 13, .	36.5	680	28.44	1,088	588	25.33	670
14, .	41.5	584	25.34	1,250	644	27.35	883
15, .	48.0	598	27.21	1,220	646	27.50	692
16, .	44.0	638	25.73	1,490	616	27.10	1,065
17, .	39.0	585	23.76	1,780	617	26.66	1,327
18, .	39.0	618	24.50	1,121	583	25.09	354
19, .	-	608	24.09	836	663	27.99	1,092
Averages, .	41.3	616	25.58	1,255	622	26.72	869

Weight of Sheep I. at beginning of period, ... 113.00 lbs.
Weight of Sheep II. at beginning of period, . . . 113.00 "
Weight of Sheep I. at end of period, ... 113.00 "
Weight of Sheep II. at end of period, ... 113.00 "

PERIOD XIV.

[Food consumed daily: 600 grams hay (*a*), 300 grams winter wheat bran and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP I.			SHEEP II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	1,181	38.21	1,644	1,017	31.64	1,669
14, . .	50.0	989	31.82	1,869	1,093	34.24	1,523
15, . .	55.5	1,002	33.28	2,225	983	30.62	2,061
16, . .	56.0	978	32.47	2,108	1,116	33.30	2,009
17, . .	59.5	1,080	34.40	2,145	1,172	34.45	1,803
18, . .	58.0	959	32.19	2,161	1,124	33.09	1,847
19, . .	60.0	1,057	33.40	2,304	1,167	32.48	2,193
Averages, .	55.0	1,035	33.68	2,065	1,096	32.83	1,872

Weight of Sheep I. at beginning of period, . . . 114.25 lbs.
Weight of Sheep II. at beginning of period, . . . 117.00 "
Weight of Sheep I. at end of period, ... 113.75 "
Weight of Sheep II. at end of period, ... 117.00 "

The data presented in the preceding tables enable us to calculate the digestion coefficients, which follow : —

PERIOD I.

English Hay (a).

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
72 grams waste, ...	60.69	18.74	2.08	7.41	25.84
Total consumed, ...	735.63	236.79	23.64	81.53	343.80
342.71 grams manure air dry, . .	309.47	92.59	12.03	34.69	142.16
Grams digested, ...	426.16	144.20	11.61	46.84	201.64
Per cent. digested, ...	57.93	60.90	49.11	57.45	58.65

SHEEP II.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
368.66 grams manure air dry, . .	330.54	99.03	12.39	38.14	153.30
Grams digested, ...	465.78	156.50	13.33	50.80	216.34
Per cent. digested, ...	58.49	61.24	51.82	57.11	58.52

SHEEP III.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
73 grams waste, ...	62.34	20.04	1.93	7.08	27.06
Total consumed, ...	733.98	235.49	23.79	81.86	342.58
337.27 grams manure air dry, . .	307.02	88.85	13.35	36.07	140.19
Grams digested, ...	426.96	146.64	10.44	45.79	202.39
Per cent. digested, ...	58.17	62.27	43.88	55.88	59.07

SHEEP IV.

900 grams hay fed, ...	796.32	255.53	25.72	88.94	369.64
328.91 grams manure air dry, . .	306.02	88.62	11.90	33.35	143.89
Grams digested, ...	490.30	166.91	13.82	55.59	225.75
Per cent. digested, ...	61.57	65.32	53.73	62.49	61.07
Average per cent. digested, . . .	**59.04**	**62.44**	**49.63**	**58.23**	**59.33**

Average nutritive ratio of ration for four sheep, 1 : 8.00.

PERIOD II.

English Hay (*b*).

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed,	790.30	256.84	18.10	76.97	375.24
399.76 grams manure air dry,	364.34	114.19	9.65	32.97	166.00
Grams digested,	425.96	142.65	8.45	44.00	209.24
Per cent. digested,	53.89	55.54	46.67	57.16	55.76

SHEEP II.

900 grams hay fed,	790.30	256.84	18.10	76.97	375.24
395.43 grams manure air dry,	361.15	109.79	9.29	36.76	162.27
Grams digested,	429.15	147.06	8.81	40.21	212.97
Per cent. digested,	54.33	57.25	48.65	52.23	56.76

English Hay (*c*).

SHEEP III.

900 grams hay fed,	795.60	265.96	20.21	77.49	374.01
392.01 grams manure air dry,	360.26	113.60	11.06	33.07	164.10
Grams digested,	435.34	152.36	9.15	44.42	209.91
Per cent. digested,	54.72	57.30	45.28	57.32	56.12

SHEEP IV.

900 grams hay fed,	795.60	265.96	20.21	77.49	374.01
378.69 grams manure air dry,	348.44	108.92	10.41	31.15	156.38
Grams digested,	447.16	157.04	9.80	46.34	217.63
Per cent. digested,	56.20	59.04	48.50	59.82	58.19
Average per cent. digested,	**54.94**	**57.29**	**46.82**	**58.10**	**56.69**

Average nutritive ratio of ration for Sheep I., III. and IV., 1 : 8.59.

Hays *b* and *c* were from the same lot, but the tests were made at different times and two separate samples were taken. The average of the analyses of the two analyses and of the digestion coefficients from Sheep I., III. and IV. was used in computing the digestibility of the grains fed. This average has been called hay *d*. Sheep II., while the results are given above, was not included in the average. The period in case of this sheep lasted but three days, and the amount of protein digested is too low.

PERIOD III.

Vetch and Oats.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
364.5 grams manure air dry, . .	321.21	95.98	16.64	40.18	130.48
Grams digested, ...	444.87	179.43	3.35	62.63	155.82
Per cent. digested, ...	58.07	65.16	16.75	60.92	54.42

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
353.4 grams manure air dry, . .	320.68	91.17	15.91	42.68	132.06
Grams digested, ...	445.40	184.24	4.08	60.13	154.24
Per cent. digested, ...	58.14	66.88	20.40	58.48	53.88
Average per cent. digested, . . .	**58.10**	**66.02**	**18.57**	**59.70**	**54.15**

Average nutritive ratio of ration for two sheep, 1 : 5.64.

PERIOD IV.

New-process Linseed Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	516.00	165.50	16.66	57.63	239.42
200 grams new-process linseed meal, .	178.80	14.38	7.68	73.98	71.98
Total consumed, ...	694.80	179.88	24.34	131.61	311.40
271.04 grams manure air dry, . .	252.06	75.06	8.21	36.54	107.02
Amount digested, . . .	442.74	104.82	16.13	95.07	204.38
Minus hay digested, ...	304.63	103.39	8.27	33.57	142.04
Remains linseed meal digested, . .	138.11	1.43	7.86	61.50	62.34
Per cent. digested, ...	77.24	99.47	102.20?	83.12	86.60

Nutritive ratio of ration for one sheep, 1 : 3.68.

PERIOD V.

Buffalo Gluten Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.68	166.12	16.72	57.82	240.31
250 grams Buffalo gluten feed, . .	229.82	19.44	30.61	52.69	126.15
Total consumed, ...	747.50	185.56	47.33	110.51	366.46
253.11 grams manure air dry, . .	236.61	63.43	10.64	30.10	111.70
Total digested, ...	510.89	122.13	36.69	80.41	254.76
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	205.25	18.41	28.39	46.74	112.19
Per cent. digested, ...	89.35	94.69	92.74	88.69	88.93

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	747.50	185.56	47.33	110.51	366.46
249.43 grams manure air dry, . .	232.46	61.51	9.76	30.00	110.65
Total digested, ...	515.04	124.05	37.57	80.51	255.81
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	209.40	20.33	29.27	46.84	113.24
Per cent. digested, ...	91.11	104.56?	95.61	88.88	89.76
Average per cent. two sheep digested,	**90.23**	**99.60**	**94.17**	**88.78**	**89.34**

Average nutritive ratio of ration for two sheep, 1 : 5.85.

PERIOD VI.

Peoria Gluten Feed.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	486.20	160.30	11.76	47.35	229.97
250 grams Peoria gluten feed, . .	225.20	18.69	14.12	43.32	147.16
Total consumed, ...	711.40	178.99	25.88	90.67	377.13
277.61 grams manure air dry, . .	254.96	76.19	8.84	27.89	114.64
Amount digested, ...	456.44	102.80	17.04	62.79	262.49
Minus hay digested, ...	267.11	91.83	5.51	27.51	130.37
Remains gluten feed digested, . .	189.33	10.97	11.53	35.28	132.12
Per cent. digested, ...	84.07	58.69	81.63	81.42	89.77

PERIOD VI. (*Peoria Gluten Feed*) — Concluded.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	523.20	172.50	12.66	50.96	247.47
250 grams Peoria gluten feed, . .	224.30	18.62	14.06	43.15	146.58
Total consumed, ...	747.50	191.12	26.72	94.11	394.05
278.76 grams manure air dry, . .	264.49	74.16	10.16	28.03	121.85
Amount digested, ...	483.01	116.96	16.56	66.08	272.20
Minus hay digested, ...	287.44	98.82	5.93	29.60	140.29
Remains gluten feed digested, . .	195.57	18.14	10.63	36.48	131.91
Per cent. digested, ...	87.19	97.44	75.58	84.53	89.99
Average per cent. two sheep digested,	**85.63**	**78.06**	**78.60**	**82.97**	**89.88**

Average nutritive ratio of ration for two sheep, 1 : 6.50.

PERIOD VII.

Chicago Maize Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	518.94	166.52	16.76	57.96	240.89
250 grams Chicago maize feed, . .	224.30	20.32	20.19	58.60	123.39
Total consumed, ...	743.24	186.84	36.95	116.56	364.28
261.96 grams manure air dry, . .	239.27	65.29	10.26	33.04	110.90
Amount digested, ...	503.97	121.55	26.69	83.52	253.38
Minus hay digested, ...	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested, . .	197.59	17.57	18.37	49.77	110.46
Per cent. digested, ...	88.09	86.45	91.00	84.92	89.52

SHEEP IV.

Total consumed, as above, . .	743.24	186.84	36.95	116.56	364.28
266.19 grams manure air dry, . .	243.53	66.92	10.05	32.41	114.97
Total digested, ...	499.71	119.92	26.90	84.15	249.31
Minus hay digested, ...	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested, . .	193.33	15.94	18.58	50.40	106.39
Per cent. digested, ...	86.19	78.48	92.03	86.00	86.22
Average per cent. two sheep digested,	**87.14**	**82.46**	**91.51**	**85.46**	**87.87**

Average nutritive ratio of ration for two sheep, 1 : 5.25.

PERIOD VIII.

Chicago Gluten Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	560.82	179.96	18.11	62.64	260.33
200 grams Chicago gluten meal, . .	180.60	3.12	8.30	66.98	101.93
Total consumed, ...	741.42	183.08	26.41	129.62	362.26
262.27 grams manure air dry, . .	244.62	69.49	9.44	33.85	109.78
Total digested, ...	496.80	113.59	16.97	95.77	252.48
Minus hay digested, ...	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested, . .	165.69	1.22	7.98	59.30	98.03
Per cent. digested, ...	91.74	39.04	96.05	88.52	96.17

SHEEP II.

Total consumed, as above, . .	741.42	183.08	26.41	129.62	362.26
258.84 grams manure air dry, . .	241.08	70.58	9.26	31.19	108.68
Total digested, ...	500.34	112.50	17.15	98.43	253.58
Minus hay digested, ...	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested, . .	169.23	.13	8.16	61.96	99.13
Per cent. digested, ...	93.70	4.16	98.22	92.49	97.25
Average per cent. two sheep digested,	**92.72**	**21.60**	**97.13**	**90.50**	**96.71**

Average nutritive ratio of ration for two sheep, 1 : 4.21.

PERIOD IX.

King Gluten Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	562.18	180.40	18.15	62.79	260.96
200 grams King gluten meal, . .	183.24	2.58	36.06	70.67	71.17
Total consumed, ...	745.42	182.98	54.21	133.46	332.13
276.91 grams manure air dry, . .	254.12	69.32	12.02	32.22	116.41
Amount digested, ...	491.30	113.66	42.19	101.24	215.72
Minus hay digested, ...	331.91	112.64	8.97	36.56	154.82
Remains gluten meal digested, . .	159.39	1.02	33.22	64.68	60.90
Per cent. digested, ...	86.98	39.47	92.12	91.52	85.57

PERIOD IX. (*King Gluten Meal*) — Concluded.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	745.42	182.98	54.21	133.46	332.13
284.84 grams manure air dry, . .	259.68	75.85	10.05	31.65	118.60
Amount digested, ...	485.74	107.13	44.16	101.81	213.53
Minus hay digested, ...	331.91	112.64	8.96	36.56	154.82
Remains gluten meal digested, . .	153.83	-	35.20	65.25	58.71
Per cent. digested, ...	83.96	-	97.63	92.34	82.44
Average per cent. two sheep digested,	**85.47**	-	**94.87**	**91.93**	**84.00**

Average nutritive ratio of ration for two sheep, 1 : 4.26.

PERIOD X.

Atlas Meal.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	550.35	181.45	13.31	53.60	260.32
200 grams atlas meal, ...	182.08	17.72	28.70	77.62	56.15
Total consumed, ...	732.43	199.17	42.01	131.22	316.47
301.66 grams manure air dry, . .	285.25	78.41	9.24	43.38	121.72
Total digested, ...	447.18	120.76	32.77	87.84	194.75
Minus hay digested, ...	302.36	103.95	6.23	31.14	147.58
Remains atlas meal digested, . .	144.82	16.81	26.54	56.70	47.17
Per cent. digested, ...	79.53	94.88	92.43	73.04	84.00

SHEEP IV.

Total consumed, as above, . .	732.43	199.17	42.01	131.22	316.47
301.21 grams manure air dry, . .	284.52	74.57	9.92	43.76	121.21
Total digested, ...	447.91	124.60	32.09	87.46	195.26
Minus hay digested, ...	302.36	103.95	6.23	31.14	147.58
Remains atlas meal digested, . .	145.55	20.65	25.86	56.32	47.68
Per cent. digested, ...	79.75	116.50	90.06	72.56	84.91
Average per cent. two sheep digested,	**79.64**	**105.70**	**91.24**	**72.80**	**84.45**

Average nutritive ratio of ration for two sheep, 1 : 4.55.

PERIOD XI.

Peanut Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	483.17	159.30	11.69	47.06	228.54
300 grams peanut feed, ...	271.29	147.58	15.03	32.72	62.23
Total consumed, ...	754.46	306.88	26.72	79.78	290.77
426.66 grams manure air dry, . .	402.39	201.03	7.72	29.17	125.41
Total digested, ...	352.07	105.85	19.00	50.61	165.36
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	86.62	14.59	13.53	23.27	35.80
Per cent. digested, ...	31.93	9.88	90.01	71.12	57.52

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	754.46	306.88	26.72	79.78	290.77
426.47 grams manure air dry, . .	401.48	195.70	7.82	29.59	135.95
Total digested, ...	352.98	111.18	18.90	50.19	154.82
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	87.53	19.92	13.43	22.85	25.26
Per cent. digested, ...	32.26	13.49	89.36	70.00	40.59
Average per cent. two sheep digested,	**32.09**	**11.68**	**89.68**	**70.56**	**49.05**

Average nutritive ratio of ration for two sheep, 1 : 6.27.

PERIOD XII.

Soja-bean Meal.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
250 grams soja-bean meal, . . .	225.55	10.15	42.61	86.69	72.04
Total consumed, ...	743.41	176.33	59.33	144.53	312.33
280.46 grams manure air dry, . .	261.39	67.67	16.36	32.78	115.27
Total digested, ...	482.02	108.66	42.97	111.75	197.06
Minus hay digested, ...	305.75	103.76	8.34	33.68	142.62
Remains soja-bean meal digested, .	176.27	4.90	34.63	78.07	54.44
Per cent. digested, ...	78.15	48.27	81.28	89.97	75.57

Period XII. (*Soja-bean Meal*) — Concluded.

Sheep IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	743.41	176.33	59.33	144.53	312.33
262.49 grams manure air dry, . .	244.64	63.02	12.65	30.85	114.22
Total digested, ...	498.77	113.31	46.68	113.68	198.11
Minus hay digested, ...	305.73	103.76	8.30	33.68	142.62
Remains soja-bean meal digested, .	193.04	9.55	38.38	80.00	55.49
Per cent. digested, ...	85.58	94.09	90.09	92.20	77.02
Average per cent. two sheep digested,	**81.86**	**71.18**	**85.68**	**91.08**	**76.29**

Average nutritive ratio of ration for two sheep, 1 : 3.73.

Period XIII.

Rye Meal.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	479.60	158.12	11.61	46.71	226.85
300 grams rye meal, ...	257.22	4.60	4.60	35.04	209.97
Total consumed, ...	736.82	162.72	16.21	81.75	436.82
255.81 grams manure air dry, . .	242.89	73.00	7.77	25.35	109.86
Total digested, ...	493.73	89.72	8.44	56.40	326.96
Minus hay digested, ...	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested, . .	230.24	–	3.01	29.26	198.36
Per cent. digested, ...	89.51	–	65.37	83.46	94.47

Sheep II.

Total consumed, as above, . .	736.82	162.72	16.21	81.75	436.82
267.15 grams manure air dry, . .	254.21	74.96	7.88	24.70	120.60
Total digested, ...	482.61	87.76	8.33	57.05	316.22
Minus hay digested, ...	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested, . .	219.12	–	2.90	29.91	187.62
Per cent. digested, ...	85.18	–	62.98	85.31	89.34
Average per cent. two sheep digested,	**87.34**	–	**64.17**	**84.38**	**91.90**

Average nutritive ratio of ration for two sheep, 1 : 7.60.

PERIOD XIV.

Winter Wheat Bran.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
300 grams winter wheat bran, . .	258.81	27.53	12.86	40.40	158.37
Total consumed, ...	776.67	193.71	29.58	98.24	398.66
336.73 grams manure air dry, . .	313.86	88.47	14.46	33.17	141.93
Total digested, ...	462.81	105.24	15.12	65.07	256.73
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	157.06	1.48	6.82	31.39	114.11
Per cent. digested, ...	60.68	5.37	53.02	77.69	72 05

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	776.67	193.71	29.58	98.24	398.66
328.31 grams manure air dry, . .	305.69	83.54	10.94	32.80	142.39
Total digested, ...	470.98	110.17	18.64	65.44	256.27
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	165.23	6.41	10.34	31.76	113.65
Per cent. digested, ...	63.83	23.29	80.39	78.65	71.76
Average per cent. two sheep digested,	62.25	14.33	66.70	78.17	71.90

Average nutritive ratio of ration for two sheep, 1 : 6.23.

See tables containing compilation of all American digestion experiments, at the end of this report.

2. CONCERNING THE DIGESTIBILITY OF THE PENTOSANS.

By J. B. Lindsey and E. B. Holland.

During the past five or six years much attention has been given to the study of the pentosans. Fischer, Tollens, Schulze, Stone and many others have investigated their chemical character, and noted their very general occurrence in our woods and agricultural plants and seeds.

The pentosans have the composition $(C_5H_8O_4)n$, and by inversion with dilute mineral acids yield, so far as known, two sugars, namely, *xylose* and *arabinose*, $C_5H_{10}O_5$. The pentosan which yields xylose is more generally found in our agricultural plants. Pentoses * $(C_5H_{10}O_5)$ have been found to exist in the juices of a great variety of growing plants. Whether they are formed by direct assimilation, or from the hexoses, is not yet fully settled. Xylan and araban belong, generally speaking, to the so-called *hemicelluloses*. E. Schulze † has applied this name to those portions of the cellular structure of plants that are not soluble in water, but in dilute mineral acids. That they cannot always be strictly considered as hemicellulose is made clear from the recognition by Schulze and Winterstein ‡ of a pentosan in *amyloid*, a substance extracted with water from the seeds of *Tropæolum majus*. In some cases, also, they approach in character the true cellulose.§ Schulze ‖ has also recognized the pentosans in the cotyledons and endosperms of many seeds, and they undoubtedly serve, just as do galactan, starch, etc., as a reserve material, supporting the life of the young plant during the process of germination. That the pentosans in the matured plants and seeds form a part of the cell walls and are dissolved during germination is quite clear from the numerous microscopic investigations made by Professor Cramer* and Dr. Pfister† in connection with Schulze's work.

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* G. de Chalmot, Am. Chem. Jour., **15**, 21.

† Zeitschr. f. physiol. Chemie, **14**.

‡ Zeitschr. f. physiol. Chemie, **15**; Berichte der chem. Ges., **24**, 2277.

§ Zeitschr. f. physiol. Chemie, **16**; also Winterstein *loco citato*.

‖ *Loco citato*.

Concerning the value of the pentosans as a source of food for animals, the results of two investigations have been published. Stone‡ fed corn meal and bran to rabbits, and found that about 60 per cent. of the pentosans were digested. A like conclusion was drawn by Stone and Jones,§ as a result of the examination of the food and fæces of sheep fed upon the hay of different grasses. Ebstein‖ has also shown that both xylose and arabinose are but little assimilated by human beings, these sugars being recognized in the urine a few hours after being eaten.

During the spring and autumn of 1893 the writer made digestion experiments with hay, corn cobs, brewers' grains and several concentrated fodder articles. These results have already been published.¶ We have thought it of sufficient interest to determine the amount of pentosans in each of the foods fed and in the fæces excreted, and thus note their degree of digestibility.**

The method employed for determining the furfurol, and consequently the pentosans, was the one described by Flint and Tollens,†† being a modification of the method originally introduced by de Chalmot and Tollens.‡‡

Pentosans differ from true carbohydrates in yielding furfurol instead of lævulinic acid when boiled with hydrochloric acid of a certain strength. Their detection and estimation depends upon the production and separation of furfurol, and its subsequent precipitation with phenyl-hydrazin as furfurol hydrazon.

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* Zeitschr. physiol. Chem., **14**, 227

† Zeitschr. physiol. Chem., **19**, 44.

‡ Am. Chem. Jour., **14**, 9.

§ Agricultural Science, **5**, 6.

‖ Archiv. pathol. Anat., **129**, 401.

¶ Massachusetts State Experiment Station, Eleventh Annual Report, 1893.

** While it is possible to estimate the amount of furfurol in the fæces with a fair degree of accuracy, it must be admitted that it is by no means certain that this furfurol is a true indicator of the amount of pentosans present; *i.e.*, it has not as yet been shown whether the pentosan molecule remains entirely intact during the digestive process. From our present knowledge it must be assumed that such is the case.

†† E. R. Flint, Inaugural Dissertation, Göttingen, 1892; Landw. Vers. Stat., **42**, 398.

‡‡ Inaugural Dissertation, Göttingen, 1891.

Method.

Weigh out 3 to 5 grams (depending on the amount of pentosans present) of the finely ground material, and transfer to a 300 cubic centimeter flask. After adding 100 cubic centimeters of hydrochloric acid of 1.06 specific gravity, connect with a Liebig condenser, and distil 30 cubic centimeters, taking ten to fifteen minutes for the distillation. Instead of putting the flask in Rose's metal to diffuse the heat, as Flint and others suggest, we have placed it upon a piece of gauze with equally satisfactory results. Now add 30 cubic centimeters more acid by means of a separatory funnel (the stem of which passes through the cork into the flask), and so continue the process until a drop of the distillate gives no red coloration on filter paper that has been moistened with aniline acetate (a few drops of aniline in a little 50 per cent. acetic acid). Ten to eleven distillations are generally sufficient. Flint has shown that for constant results the presence of a certain amount of salt in a definite quantity of solution is essential. Furfurol hydrazon is more insoluble with 81 grams of sodium chloride in 400 cubic centimeters of distillate than when less is present, and these proportions should be always used. Add to the obtained distillate, brought into a 700 to 800 cubic centimeter beaker, the necessary amount of salt and water to raise it to this standard (see table following).

Distillate (Cubic Centimeters).	Water (Cubic Centimeters).	Salt to be added (Grams).	Distillate (Cubic Centimeters).	Water (Cubic Centimeters).	Salt to be added (Grams).
400	–	–	150	250	50.75
350	50	10.15	100	300	60.90
300	100	20.30	50	350	71.05
250	150	30.45	–	400	81.20
200	200	40.60			

Neutralize exactly the 400 cubic centimeter solution with sodium carbonate, covering the beaker with a watch glass during the process, and make up to 500 cubic centimeters with water. Add now 10 cubic centimeters of phenyl-hydrazin solution,* precipitating the furfurol as furfurol hydrazon.† Stir thirty minutes, preferably with an automatic stirrer, and filter the solution, using suction, into glass drying tubes about three-quarters of an inch in diameter and six to seven inches long, drawn out at the lower end and filled with about one-half inch of glass wool in preference to asbestos. Remove adhering particles with a feather, and do not use over 100 cubic centimeters of wash water. Dry the precipitate in a specially constructed air bath (see cut) at 55° to 60° C. for three hours. To hasten and perfect the drying a partial vacuum is made by drawing dry air slowly through the tubes by aid of a suction pump, the air supply being regulated by pinchcocks. The air before entering the tubes is conducted through sulphuric acid to dry it, and through a glass tube containing small pieces of marble to remove any sulphuric acid that might be carried over mechanically. Cool the tubes in a desiccator and weigh. Dissolve out the precipitate with hot alcohol and reweigh, and consider the loss in weight as furfurol hydrazon. (See cut of apparatus at end of this article.)

For the conversion of furfurol hydrazon to furfurol use the following factors: —

Furfurol = furfurol hydrazon × 0.538.
Arabinose = furfurol hydrazon × 1.229 + 0.0177.
Xylose = furfurol hydrazon × 1.031 — 0.001.
Pentose (average arabinose and xylose) = furfurol hydrazon × 1.13 + 0.0083.
Pentosan = pentose × 0.88.

Formulas.

Furfurol = $C_4H_3O - COH$.
Phenyl-hydrazin = $C_6H_5 - NH - NH_2$.
Furfurol hydrazon = $C_4H_3O\,CH\,C_6H_5N_2H$.
Pentose = $(C_5H_{10}O_5)\,n$.
Pentosans = $(C_5H_8O_4)\,n$.

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* Twelve grams of phenyl-hydrazin and 7.5 grams of glacial acetic acid filled to 100 cubic centimeters with water and well shaken.

† After the addition of the phenyl-hydrazin reagent, the solution should react *slightly* acid. In case this is not so, add the necessary acetic acid.

In Table I. will be found the percentages of furfurol, pentosans and extract matter found in the feeds consumed. It will be seen that the pentosans equal from one-third to one-half of the extract matter.

Table II. shows the percentages of pentosans in the excreta of the sheep during the different feeding periods.

TABLE I. — *Pentosans in Food tested.**

No. of Period.	FOODS TESTED.	Dry Matter (Per Cent.).	No. of Grams taken for Furfurol Estimation.	AIR-DRY MATERIAL.		DRY MATTER.		
				Furfurol Hydrazon found (Grams).		Equivalent Per Cent. Furfurol.	Equivalent Per Cent. Pentosans.	Per Cent. Nitrogen-free Extract.
				a.	*b.*			
1	Hay (*a*), ...	94.09	4	0.7633	0.7656	10.93	20.41	48.51
2	Buffalo gluten feed, . .	92.92	5	0.7968	0.7913	9.20	17.16	50.20
3	Hay (*b*), ...	93.63	3	0.6140	0.6393	12.00	22.43	45.56
4	New-process linseed meal,	91.75	4	0.4860	0.4950	7.19	13.49	41.16
5	Old-process linseed meal,	90.81	4	0.4807	0.4916	6.54	13.49	39.80
6	Corn cobs, ...	92.27	3	0.8643	0.8651	16.80	31.34	65.77
7	Dried brewers' grains, .	93.46	4	0.9205	0.9111	13.17	24.57	51.09
8	Spring wheat bran, . .	92.72	3	0.8188 0.7902	0.8111	15.60	29.07	59.39
9	Winter wheat bran, . .	91.49	3	0.6877 0.6675	0.6620	13.17	24.63	62.83

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* In a former article, published in "Agricultural Science," concerning the digestibility of the pentosans, the percentages of pentosans were calculated by multiplying the per cent. of furfurol by 1.38. This was the old way, and if none of the pentosans were destroyed in the process of distillation it would give the correct percentage. It gives, however, considerably lower percentages than when the formula as suggested by Flint is used. The digestion coefficients would not be affected, however. In the present calculations we have used Flint's formula, believing it to be much nearer correct.

TABLE II. — *Pentosans in Manure excreted.*

No. of Period.	FOODS TESTED.	Dry Matter (Per Cent.).	Grams taken for Furfurol Estimation.	AIR-DRY MATERIAL.		DRY MATTER.	
				Furfurol Hydrazon found (Grams).		Equivalent Per Cent. Furfurol.	Equivalent Per Cent. Pentosans.
	Hay (a).			*a.*	*b.*		
I.	Sheep II., ...	92.96	4	0.6996	0.7210	10.27	19.20
	Sheep III., ...	93.33	4	0.6990	0.7060	10.12	18.92
	Sheep IV., ...	92.34	4	0.7395	0.7358	10.74	20.08
	Buffalo Gluten Feed.						
II.	Sheep II., ...	91.54	5	0.8520	0.8620	10.07	18.76
	Sheep IV., ...	92.20	5	0.8758	0.8824	10.26	19.13
	Hay (b).						
III.	Sheep I., ...	93.00	4	0.6880 0.6920	0.7190	10.10	18.91
	Sheep II., ...	92.59	4	0.7390	0.7310	10.67	19.94
	Sheep III., ...	92.38	4	0.6804	0.7149	10.15	18.98
	Sheep IV., ...	91.74	4	0.6657	0.6596	9.71	18.16
	New-process Linseed Meal.						
IV.	Sheep II., ...	94.62	3	0.5210	0.5165	9.83	18.45
	Sheep III., ...	94.57	4	0.6387	-	9.08	16.97
	Old-process Linseed Meal.						
V.	Sheep II., ...	94.62	4	0.6762	0.6476	9.41	17.60
	Sheep III., ...	94.48	4	0.6677	0.6390	9.29	17.40
	Sheep IV., ...	94.90	4	0.6520	0.6415	9.17	17.15
	Corn Cobs.						
VI.	Sheep I., ...	93.25	3	0.5940	0.5950	11.43	21.40
	Sheep II., ...	92.71	3	0.6057	0.6140	11.80	22.08
	Dried Brewers' Grains.						
VII.	Sheep I., ...	95.51	4	0.8705	0.8500	12.20	22.60
	Sheep II., ...	94.43	4	0.8756	0.8817	12.52	23.34
	Spring Wheat Bran.						
VIII.	Sheep II., ...	94.76	4	0.8573	0.8623	12.20	22.76
	Sheep III., ...	94.73	4	0.8240	0.8400	11.82	22.04
	Winter Wheat Bran.						
IX.	Sheep IV., ...	95.43	4	0.7810	0.7730	10.94	20.45

The data furnished in the above tables enable us to calculate the digestibility of the pentosans, as found in the tables following: —

DIGESTIBILITY OF PENTOSANS. — *Period I. English Hay.*

SHEEP II.		SHEEP III.		SHEEP IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
749 28 grams hay eaten, . . .	152.93	754.12 grams hay eaten, . . .	153.91	769.50 grams hay eaten, . . .	157.05
294.67 grams manure excreted, . .	56.58	286.50 grams manure excreted, . .	54.20	296.78 grams manure excreted, . .	59.59
Grams pentosans digested, . . .	96.35	Grams pentosans digested, . . .	99.71	Grams pentosans digested, . . .	97.46
Per cent. pentosans digested, . .	63.00	Per cent. pentosans digested, . .	64.80	Per cent. pentosans digested, . .	62.10
Average per cent. pentosans digested (three sheep), ... 63.30					

Period II. — Buffalo Gluten Feed.

SHEEP II.		SHEEP IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
491.35 grams hay fed, ...	100.28	528.30 grams hay fed, ...	107.83
271.77 grams Buffalo gluten fed, ...	46.64	225.00 grams Buffalo gluten fed, ...	38.61
Total consumed, ...	146.92	Total consumed, ...	146 44
259.73 grams manure excreted, ...	48.73	247.77 grams manure excreted, ...	47.40
Grams digested, ...	98.19	Total digested, ...	99.04
Minus pentosans digested in hay, ...	63.18	Minus pentosans digested in hay, ...	66.96
Grams pentosans digested, ...	35.01	Grams pentosans digested, ...	32.08
Per cent. pentosans digested, ...	75.10	Per cent. pentosans digested, ...	83.10
Average per cent. pentosans digested (two sheep), ... 79.10			

Period III. — Hay (b).

SHEEP I.		SHEEP II.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
337.95 grams manure excreted,	63.91	343.62 grams manure excreted,	68.52
Grams pentosans digested,	107.76	Grams pentosans digested,	103.15
Per cent. pentosans digested,	62.70	Per cent. pentosans digested,	60.10

SHEEP III.		SHEEP IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
339.33 grams manure excreted,	64.40	337.83 grams manure excreted,	61.35
Grams pentosans digested,	107.27	Grams pentosans digested,	110.32
Per cent. pentosans digested,	62.50	Per cent. pentosans digested,	64.30
Average per cent. pentosans digested (four sheep),			62.40

Period IV. — New-process Linseed Meal.

SHEEP II.		SHEEP III.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
526.38 grams hay fed,	118.07	526.38 grams hay fed,	118.07
220.70 grams new-process linseed meal fed,	29.79	220.70 grams new-process linseed meal fed,	29.79
Total consumed,	147.86	Total consumed,	147.86
280.76 grams manure excreted,	51.80	271.77 grams manure excreted,	46.12
Grams digested,	96.06	Grams digested,	101.74
Minus pentosans digested in hay,	70.96	Minus pentosans digested in hay,	73.78
Grams pentosans digested,	25.10	Grams pentosans digested,	27.96
Per cent. pentosans digested,	84.30	Per cent. pentosans digested,	93.90
Average per cent. pentosans digested (two sheep),			89.10

Period V. — Old-process Linseed Meal.

SHEEP II.		SHEEP III.		SHEEP IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
517.38 grams hay fed,	116.05	517.38 grams hay fed,	116.05	526.38 grams hay fed,	118.07
218.18 grams old-process linseed meal fed,	29.45	218.18 grams old-process linseed meal fed,	29.45	220.00 grams old-process linseed meal fed,	29.70
Total consumed,	145.50	Total consumed,	145.50	Total consumed,	147.77
285.76 grams manure excreted,	50.29	268.10 grams manure excreted,	46.65	280.20 grams manure excreted,	48.05
Total digested,	95.21	Total digested,	98.85	Total digested,	99.72
Minus pentosans digested in hay,	69.75	Minus pentosans digested in hay,	72.53	Minus pentosans digested in hay,	75.92
Grams pentosans digested,	25.46	Grams pentosans digested,	26.32	Grams pentosans digested,	23.80
Per cent. pentosans digested in hay,	86.40	Per cent. pentosans digested in hay,	89.40	Per cent. pentosans digested in hay,	80.10
Average per cent. pentosans digested (three sheep),				85.30	

Period VI. — Corn Cobs.

Sheep I.		Sheep II.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
384.03 grams hay fed,	86.14	334.48 grams hay fed,	75.02
351.56 grams corn cobs fed,	110.17	351.56 grams corn cobs fed,	110.18
220.25 grams new-process linseed meal fed,	29.73	177.14 grams new-process linseed meal fed,	23.91
Total consumed,	226.05	Total consumed,	209.11
353.05 grams manure excreted,	75.55	331.73 grams manure excreted,	73.25
Total digested,	150.50	Total digested,	135.86
Minus pentosans in hay and linseed meal digested,	80.49	Minus pentosans in hay and linseed meal digested,	65.25
Grams pentosans digested,	70.01	Grams pentosans digested,	70.61
Per cent. pentosans digested,	63.50	Per cent. pentosans digested,	64.10
Average per cent. pentosans digested (two sheep),		63.80	

Period VII. — Dried Brewers' Grains.

Sheep I.		Sheep II.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
433.00 grams hay consumed,	97.12	433.00 grams hay consumed,	97.12
358.72 grams brewers' grain consumed,	88.14	358.72 grams brewers' grain consumed,	88.14
Total consumed,	185.26	Total consumed,	185.26
328.83 grams manure excreted,	74.32	331.87 grams manure excreted,	77.45
Total digested,	110.94	Total digested,	107.81
Minus pentosans in hay digested,	60.89	Minus pentosans in hay digested,	58.37
Grams pentosans digested,	50.05	Grams pentosans digested,	49.44
Per cent. pentosans digested,	56.80	Per cent. pentosans digested,	56.10
Average per cent. pentosans digested (two sheep),		56.40	

Period VIII. — Spring Wheat Bran.

SHEEP II.		SHEEP III.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
523.44 grams hay fed,	117.41	523.44 grams hay fed,	117.41
261.93 grams spring bran fed,	76.14	261.93 grams spring bran fed,	76.14
Total fed,	193.55	Total fed,	193.55
333.84 grams manure excreted,	75.98	329.49 grams manure excreted,	72.62
Total digested,	117.57	Total digested,	120.93
Minus pentosans in hay digested,	70.56	Minus pentosans in hay digested,	73.38
Grams pentosans digested,	47.01	Grams pentosans digested,	47.55
Per cent. pentosans digested,	61.70	Per cent. pentosans digested,	62.50
Average per cent. pentosans digested (two sheep),		62.10	

Period IX. — Winter Wheat Bran.

SHEEP IV.	
Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
517.38 grams hay consumed,	116.05
259.47 grams winter bran consumed,	63.90
Total consumed,	179.95
315.42 grams manure excreted,	64.50
Total digested,	115.45
Minus pentosans in hay digested,	74.61
Grams pentosans digested,	40.84
Per cent. pentosans digested,	63.90

RÉSUMÉ OF RESULTS.

Comparison of the digestibility of the pentosans with the digestibility of the other fodder constituents: —

KIND OF FOOD.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).	Pentosans (Per Cent.).
Hay of mixed grasses (*a*),	61	64	51	63	63	63
Hay of mixed grasses (*b*),	56	57	47	57	58	62
Buffalo gluten feed, .	78	43	81	85	81	79
New-process linseed meal,	81	61	91	87	86	89
Old-process linseed meal,	79	57	89	89	78	85
Corn cobs, . . .	59	65	50	17	60	64
Dried brewers' grains, .	62	53	91	79	59	56
Spring wheat bran, .	63	24	76	80	70	62
Winter wheat bran, .	66	56	61	79	70	64

The above figures show that the pentosans in six out of nine cases are practically as digestible as any of the other groups of fodder substances.

In both samples of hay the pentosans are fully as digestible as either the cellulose or protein. In case of the dried brewers' grains and the two brans the fat and protein are noticeably more digestible than the pentosans.

With the more concentrated foods it will be observed that the pentosans are as digestible as either the fat, protein or extract matter. *The results make clear that association has a great deal to do with digestibility.* In the hays, corn cobs and brewers' grains, where the woody substance (lignin) is present to a considerable extent, the digestibility of the pentosans is noticeably less than when the incrusting substance is absent. Whether or not the pentosans are chemically united to the incrusting substances is not known, but it is not at all improbable. It is certainly clear that the incrusting substances perceptibly interfere with the digestibility of the xylan or araban. This has also been proved to be the case with cellulose, first indirectly by Henneberg and Stohmann * and later directly by F. Lehmann,† who found that when the fibre was freed from all incrusting substances the cellulose was practically all digestible.

Stone has already shown, in case of hays, bran and such fodders, that the pentosans have an average digestibility of 60 per cent., and our results with similar fodders simply confirm his investigations. With the more concentrated feeds, where little incrusting substance is present, the pentosans are as digestible as any other of the fodder groups. One might assume that if the pentosans were isolated and fed to animals they would be fully as digestible as starch or pure cellulose.

While from 60 to 90 per cent. of the pentosans in the present experiment have been removed from the digestive tract in the process of digestion, it has certainly not been demonstrated that they have been assimilated and have a food value equal to that of starch and similar substances. In case of human beings Ebstein has already proved to the contrary. We hope to be able to throw additional light upon this point in the near future.

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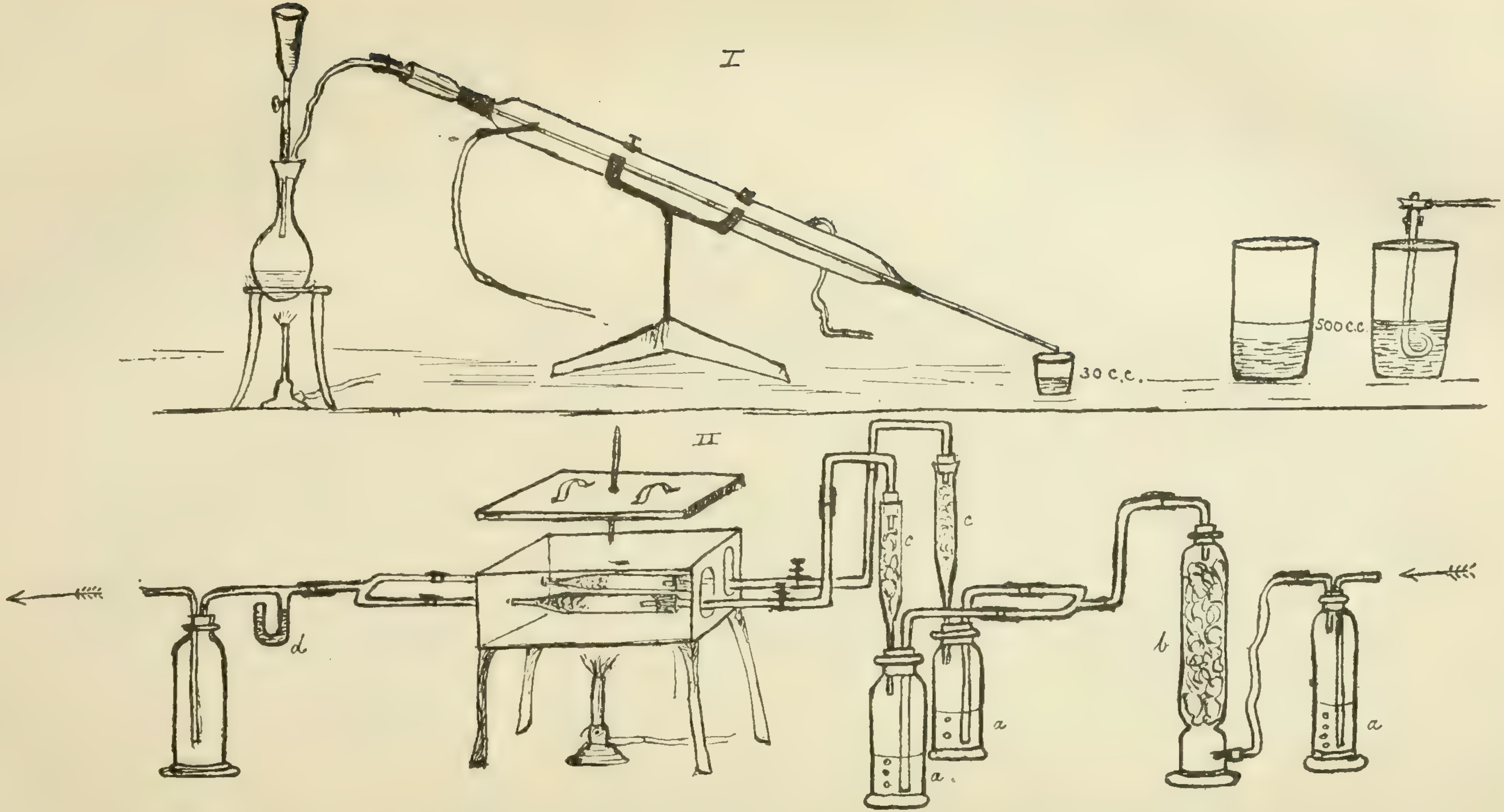
* Futterung der Wiederkauer, 1860.

† Journal f. Landw. **48**, 435.


I
II
500 c.c.
30 c.c.
a
a
a
b
c
c
d

I. Distillation Apparatus.
II. Drying Apparatus.

a. Sulphuric Acid.
b. Pumice Stone moistened with Sulphuric Acid.

c. Crushed Marble.
d. Filled with Mercury to show Vacuum.

PART II.

FIELD EXPERIMENTS.

C. A. GOESSMANN.

1. FIELD EXPERIMENTS FOR THE PURPOSE OF STUDYING THE ECONOMY OF RAISING LEGUMINOUS CROPS (CLOVER-LIKE PLANTS) AS A MEANS OF ENRICHING THE SOIL IN NITROGEN IN THE INTEREST OF THE SUBSEQUENT RAISING OF GRAIN CROPS (FIELD A).
2. FIELD EXPERIMENTS WITH SEVERAL PROMINENT VARIETIES OF POTATOES AND SOME PROMINENT MIXED FORAGE CROPS (VETCH, OATS AND HORSE BEAN, VETCH AND OATS AND VETCH AND BARLEY) (FIELD B).
3. FIELD EXPERIMENTS TO ASCERTAIN THE INFLUENCE OF DIFFERENT MIXTURES OF COMMERCIAL FERTILIZERS ON THE YIELD AND GENERAL CHARACTER OF SEVERAL PROMINENT GARDEN CROPS (FIELD C).
4. EXPERIMENTS WITH FORAGE CROPS (FIELD D), ILLUSTRATED WITH CUTS OF ROOTS OF FOUR PROMINENT LEGUMINOUS CROPS (VETCH, SOJA BEAN, LUPINE AND HORSE BEAN).
5. TRIAL OF AN EARLY MATURING VARIETY OF MINNESOTA DENT CORN, HURON (FIELD E).
6. FIELD EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES, TO STUDY THE ECONOMY OF USING THE CHEAPER NATURAL PHOSPHATES OR THE MORE COSTLY ACIDULATED PHOSPHATES (FIELD F).
7. EXPERIMENTS WITH FORAGE CROPS (VETCH AND OATS AND HUNGARIAN GRASS) (FIELD G).
8. FIELD EXPERIMENTS TO STUDY THE EFFECT OF PHOSPHATIC SLAG AND NITRATE OF SODA, AS COMPARED WITH GROUND BONE, ON THE YIELD OF OATS AND CORN (EAST FIELD).
9. EXPERIMENTS WITH PERMANENT GRASS LANDS (MEADOWS) (EAST FIELD).
10. ORCHARD EXPERIMENTS WITH HOME-MADE STABLE MANURE, UNLEACHED WOOD ASHES AND SEVERAL MIXTURES OF FERTILIZING MATERIALS ON THE GROWTH AND YIELD OF SEVERAL VARIETIES OF FRUIT TREES.
11. OBSERVATIONS IN VEGETATION HOUSE.
12. REPORT ON GENERAL FARM WORK.

1. FIELD EXPERIMENTS FOR THE PURPOSE OF STUDYING THE ECONOMY OF RAISING LEGUMINOUS CROPS (CLOVERS, ETC.) AS A MEANS OF ENRICHING THE SOIL IN NITROGEN IN THE INTEREST OF THE SUBSEQUENT RAISING OF GRAIN CROPS.

Field A.

The systematic treatment of the field here under consideration, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-tenth of an acre each) of a uniform size and shape, one hundred and thirty-two feet long and thirty-three feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

Since 1889 the main object of observations upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood or of barn-yard manure. A corresponding amount of available nitrogen was applied in all these cases.

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of the three essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner and as far as practicable on the same day in case of every plat during the same year.

The subsequent tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early in the spring as circumstances permitted. They were well harrowed under before the seed was planted in rows by a seed drill.

PLATS.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Cost of Fertilizers applied to Field A.

	Cost per Plat.	Cost per Acre.
Plat 0, ...	$2 28	$22 75
Plat 1, ...	1 99	19 90
Plat 2, ...	2 43	24 30
Plat 3, ...	2 09	20 90
Plat 4, ...	1 23	12 30
Plat 5, ...	2 46	24 58
Plat 6, ...	2 02	20 18
Plat 7, ...	1 23	12 30
Plat 8, ...	2 02	20 18
Plat 9, ...	1 23	12 30
Plat 10, ...	2 53	25 30

The above-described course of the general management of the experiment has been followed thus far for five consecutive years (1889–93, inclusive).

Kind of Crops raised.

Corn (maize),	in 1889.
Oats,	in 1890.
Rye,	in 1891.
Soja bean,	in 1892
Oats,	in 1893.

The annual yield of the various crops upon the different plats showed that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that received annually in some form or other an addition of a corresponding amount of available nitrogen.

The results of our observations were stated as follows: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen, to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892).

1893. — The main object of our experiment upon Field A during that season was to observe the after-effect of the cultivation of soja bean (a leguminous crop) on the nitrogen resources of the soil which served for its production. It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of the succeeding crop upon those plats (4, 7, 9) which as a rule did not receive at any time an addition of available nitrogen from any other manurial source but the atmospheric air and the roots of the soja beans left in the soil after harvesting the crop.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years (see tenth annual report).

Yield of Oat Crop on Different Plats (1893).

[Pounds.]

	Weight of Oats.	Weight of Oats per Acre.	Weight of Straw and Chaff.	Weight of Grain.	Weight of Straw and Chaff per Acre.	Weight of Grain per Acre.
Plat 0, . . .	530	5,300	399	131	3,990	1,310
Plat 1, . . .	690	6,900	555	135	5,550	1,350
Plat 2, . . .	600	6,000	454	146	4,540	1,460
Plat 3, . . .	700	7,000	534	166	5,340	1,660
Plat 4, . . .	590	5,900	430	160	4,300	1,600
Plat 5, . . .	630	6,300	551	79	5,510	790
Plat 6, . . .	600	6,000	498	102	4,980	1,020
Plat 7, . . .	550	5,500	431	119	4,310	1,190
Plat 8, . . .	420	4,200	325	95	3,250	950
Plat 9, . . .	480	4,800	370	110	3,700	1,100
Plat 10, . . .	610	6,100	485	125	4,850	1,250

Ratio of Grain to Straw.

Plat 0, ...	1:3	Plat 6, ...	1:4.9
Plat 1, ...	1:4.1	Plat 7, ...	1:3.6
Plat 2, ...	1:3.1	Plat 8, ...	1:3.4
Plat 3, ...	1:3.2	Plat 9, ...	1:3.4
Plat 4, ...	1:2.7	Plat 10, ...	1:3.9
Plat 5, ...	1:7		

Conclusions. — An examination of the results given above shows that the total crop per acre on those plats to which no nitrogen was applied (4, 7 and 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Plat 8 shows again the exceptional conditions of previous years, for, although fertilized in a like manner as Plat 6, its total yield was 1,800 pounds less.

In yield of grain those plats which received their nitrogen in the form of sulphate of ammonia (5, 6 and 8) averaged 92 pounds; those in the form of organic nitrogen (0, 6 and 8), 140⅔ pounds; those in the form of nitrate of soda (1 and 2), 140½ pounds.

The best results in relation of total yield to yield of grain were obtained in the case of those plats receiving organic nitrogen (dried blood and barn-yard manure), or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to give the best satisfaction.

The total yield of crops on the plats receiving no nitrogen addition, as compared with those receiving a nitrogen supply, was during the succeeding years as follows: —

With oats in 1890, one-fifth to one-sixth less;
With rye in 1891, one-fifth to one-sixth less;
With soja bean in 1892, one-third to one-fourth less; and
With oats in 1893, one-seventh to one-eighth less.

From this it will appear that the introduction of a leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it.

It was decided to continue the observation by repeating the raising of soja beans in 1894 and oats in 1895.

1894. — To secure, if possible, more decisive results regarding the presence and absence of nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

PLATS.	Manurial Substances Applied.
Plat 0, .	800 lbs. barn-yard manure, 80½ lbs. potash-magnesia sulphate and 77 lbs. dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 2, .	29 lbs. nitrate of soda (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 3, .	43 pounds dried blood (= 5 to 6 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 4, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 5, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 6, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 7, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 8, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 9, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 4 to 5 lbs. nitrogen), 97 lbs. sulphate of potash-magnesia (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).

An early maturing variety of white soja bean was the crop employed for the experiment. The field was ploughed April 18, the barn-yard manure having been previously applied to Plat 0, and a quantity of lime to Plat 8.* Plats 1–10 received their fertilizer mixtures applied broadcast on May 10. After proper preparation of the soil the soja beans were planted on May 12 in drills two and one-half feet apart, six pounds of seed being used per plat. The plants appeared above ground May 21. June 5 the field was cultivated and hoed, and also on the 16th and 25th and July 12.

---

* This plat had suffered for years, as noted in previous reports, from a serious attack of parasitic growth affecting the yield of the crop, and the lime was added to correct the condition of the soil and prevent, if possible, the return of the failure. The purpose for which it was applied was evidently served, for the yield of the crop was very satisfactory.

Height of Soja-bean Plants upon the Different Plats of Field A during the Season (1894).

[Inches.]

	July 3.	July 10.	July 24.
Plat 0,	12	16	24
Plat 1,	12	16	25
Plat 2,	12	19	26
Plat 3,	11	15	26
Plat 4,	11	14	25
Plat 5,	13	17	25
Plat 6,	11	16	26
Plat 7,	10	14	24
Plat 8,	12	15	27
Plat 9,	10	14	25
Plat 10,	11	16	26

The color of the crop varied somewhat on the different plats. Those receiving no nitrogen addition had a yellowish appearance throughout the season, while No. 8, which in previous years had been of inferior growth and color, appeared to do as well as any during the entire growing period. The plants began to bloom July 25. Owing to the protracted drought of July and August the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage.

Yield of Soja Bean on Different Plats (1894).

[Pounds.]

	Per Plat.	Per Acre.
Plat 0,	600	6,000
Plat 1,	625	6,250
Plat 2,	700	7,000
Plat 3,	525	5,250
Plat 4,	405	4,050
Plat 5,	645	6,450
Plat 6,	615	6,150
Plat 7,	480	4,800
Plat 8,	680	6,800
Plat 9,	470	4,700
Plat 10,	570	5,700

Conclusions.

1. A comparison of the above-stated yield of the different plats shows that those plats (4, 7 and 9) which received no nitrogen addition from an outside source yielded on an average from 1,400 to 1,500 pounds less per acre than those receiving a nitrogen addition.

2. From these figures it appears that the increased cost of the fertilizer in the case of the plats receiving nitrogen (45 pounds nitrogen at 13 cents = $6.75) exceeds the value of the increase in crop produced by its application (allowing $5 per ton of green material containing 34.02 per cent. dry matter).

3. An increase of twice the amount of the phosphoric acid and potassium oxide as compared with earlier years (see report for 1892) has not affected the relative yield of the crop.

Analysis of Early Maturing Soja Bean.

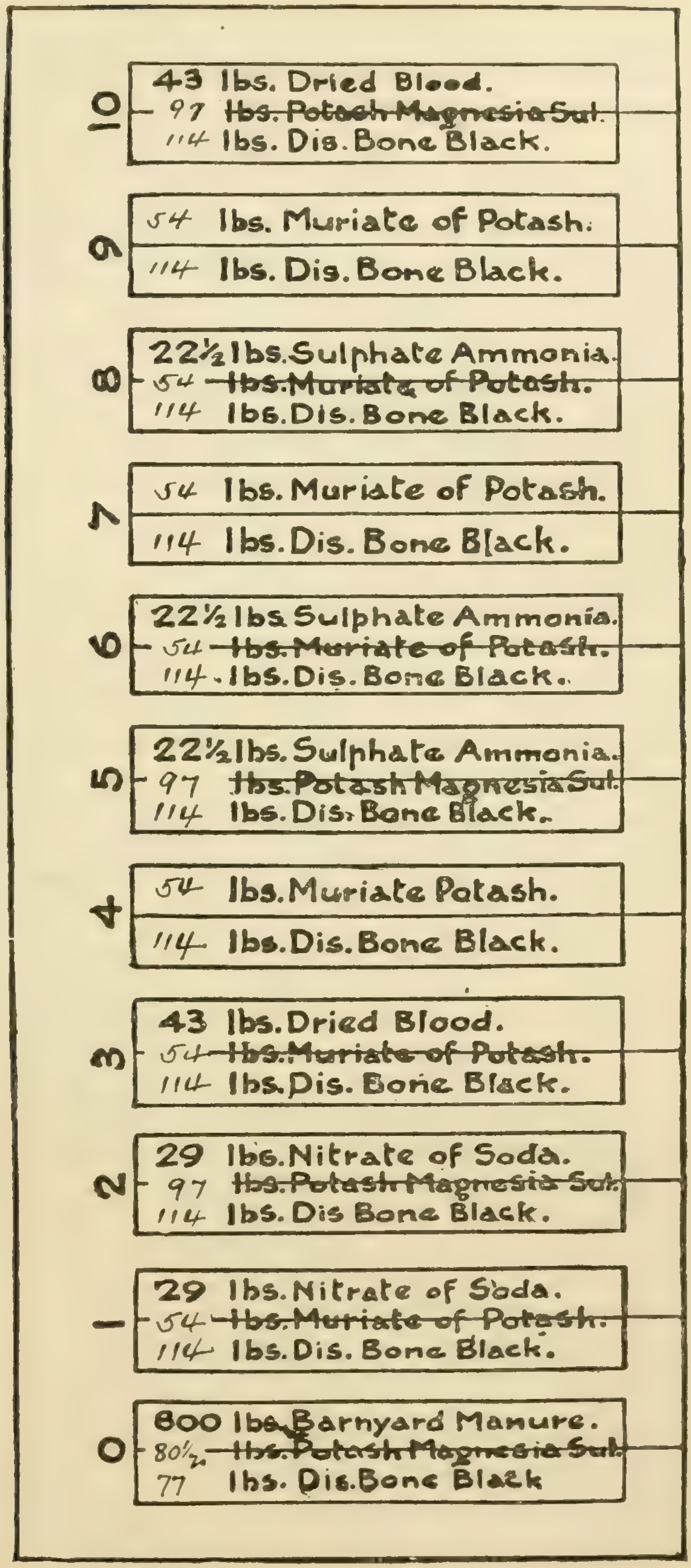
[Raised on Field A; collected when crop was cut, Aug. 28, 1894.]

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.

Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Field "A," 1894.


10
43 lbs. Dried Blood.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis. Bone Black.
9
54 lbs. Muriate of Potash.
114 lbs. Dis. Bone Black.
8
22½ lbs. Sulphate Ammonia.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
7
54 lbs. Muriate of Potash.
114 lbs. Dis. Bone Black.
6
22½ lbs. Sulphate Ammonia.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
5
22½ lbs. Sulphate Ammonia.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis. Bone Black.
4
54 lbs. Muriate Potash.
114 lbs. Dis. Bone Black.
3
43 lbs. Dried Blood.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
2
29 lbs. Nitrate of Soda.
97 ~~lbs. Potash Magnesia Sul.~~
114 lbs. Dis Bone Black.
1
29 lbs. Nitrate of Soda.
54 ~~lbs. Muriate of Potash.~~
114 lbs. Dis. Bone Black.
0
800 lbs. Barnyard Manure.
80½ ~~lbs. Potash Magnesia Sul.~~
77 lbs. Dis. Bone Black

SCALE, 4 RODS TO 1 INCH.

2. FIELD EXPERIMENTS WITH SEVERAL VARIETIES OF POTATOES AND SOME PROMINENT MIXED FORAGE CROPS.

Field B.

[*a.* Potatoes: Beauty of Hebron, Clark's and New Queen; *b.* Mixed forage crops: vetch, oats and horse bean, vetch and oats and vetch and barley.]

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21.

For details regarding the work carried on upon Field B previous to 1892, see tenth annual report.

The character of the crops raised during 1892 may be noticed from the subsequent tabular statement: —

Crops raised in 1892.

PLATS.	1892.	Yield of Hay, First and Second Cut (Pounds).	Rate per Acre (Pounds).
Plat 11,	Kentucky blue-grass, sown Sept. 24, 1889, . . .	335	2,513
Plat 12,	Kentucky blue-grass and red-top, sown Sept. 18, 1891,	365	2,737
Plat 13,	English rye-grass and Italian rye-grass, sown Sept. 29, 1890.	255	1,913
Plat 14,	English rye-grass and red top, sown Sept. 29, 1890, .	225	1,688
Plat 15,	Herds grass and red top, sown April 23, 1891, . .	565	4,238
Plat 16,	Italian rye-grass and red top, sown April 23, 1891, .	565	4,238
Plat 17,	Meadow fescue, sown Sept. 25, 1887, ...	475	3,563
Plat 18,	Meadow fescue, sown Sept. 29, 1890, ...	490	3,675
Plat 19,	Herds grass, sown Sept. 25, 1889, ...	610	4,575
Plat 20,	Herds grass and red top, sown Sept. 29, 1890, . .	285	2,138
Plat 21,	Meadow fescue and herds grass, sown Sept. 18, 1891,	355	2,663
	Total, ...	4,525	-

At the close of the season (1892) it was decided to raise hereafter other crops than grasses upon plats 11, 13, 14, 15, 16 and 20. For this reason they were ploughed after the rowen had been secured, while plats 12, 17, 18, 19 and 21 remained in grass for another season.

1893. — Plats 11, 13, 14, 15, 16 and 20, which had been used for several preceding years for the production of grasses, were at an early date prepared to serve for experiments with several prominent varieties of potatoes. They were ploughed in August, 1892, and were again ploughed for the final preparation April 25, 1893.

It was proposed to compare the yield, as far as quantity and quality are concerned, under otherwise corresponding circumstances. Three varieties of potatoes, Beauty of Hebron, Clark's, New Queen, were chosen for the trial. The seed potatoes were obtained of J. J. H. Gregory & Son, Marblehead.

Two plats, 15 and 16, were assigned for the cultivation of Beauty of Hebron; two, 13 and 14, for that of New Queen; and two, 11 and 20, for that of Clark's variety.

One plat in each case received its potash supply in form of muriate of potash (plats 11, 13 and 15), and one in each case in that of high-grade sulphate of potash (plats 14, 16, 20). The actual amount of potassium oxide used in all cases remained the same.

Statement of Fertilizers used (Pounds).

		Per Plat.	Per Acre.
Plats 11, 13, 15,	Muriate of potash, ...	54	400
	Bone, ...	80	600
Plats 14, 16, 20,	Sulphate of potash (high grade), .	54	400
	Bone, ...	80	600

Composition of Fertilizers used.

[Per Cent.]

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone, ...	4.02	–	22.96
Sulphate of potash, ...	–	50.20	–
Muriate of potash, ...	–	46.00	–

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 11, 13, 15, ...	$2 39	$17 93
Plats 14, 16, 20, ...	2 66	19 95

The final mechanical preparation of the different plats was the same in all cases. The fertilizer was applied broadcast, and subsequently thoroughly harrowed in before planting. The potatoes were planted May 10 on all plats at the rate of nineteen bushels per acre, or two and one-half bushels potatoes per plat. Potatoes used were either whole ones of medium size, or when larger were cut in pieces of sizes corresponding to the former. Plats 11 and 20 were planted with Clark's variety; plats 13 and 14 were planted with New Queen variety; plats 15 and 16 were planted with Beauty of Hebron variety.

The crop began to break ground May 26, and was subsequently cultivated and hoed June 5 and June 20. The potatoes were in bloom June 24, and the tops began to die August 14. The crop was harvested August 23 and 24.

The potatoes were in all cases of a superior appearance; only one-eighth to one-ninth of the entire crop was not marketable as a first-class article, on account of small size.

YIELD OF CROP.

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 11, Clark's, . .	1,450	225	1,675	10,875	1,688	12,563
Plat 13, New Queen, . .	1,620	240	1,860	12,150	1,800	13,950
Plat 15, Beauty of Hebron,	2,160	190	2,350	16,200	1,425	17,625

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 11, Clark's, . .	–	–	–	181	28	209
Plat 13, New Queen, . .	–	–	–	203	30	233
Plat 15, Beauty of Hebron,	–	–	–	270	24	294

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . .	1,540	230	1,770	11,550	1,725	13,275
Plat 14, New Queen, . .	1,860	190	2,050	13,950	1,425	15,375
Plat 16, Beauty of Hebron,	2,190	240	2,430	16,425	1,800	18,225

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . .	–	–	–	193	29	222
Plat 14, New Queen, . .	–	–	–	233	24	257
Plat 16, Beauty of Hebron,	–	–	–	274	30	304

From an examination of the above tabular statement of the yield of the different varieties of potatoes on trial we arrived at the following conclusions: —

1. The yield of potatoes is in every instance larger in case sulphate of potash has furnished the potash of the fertilizer used than where muriate of potash has served for that purpose.

2. The yield of the three varieties of potatoes on trial, although raised under a corresponding system of cultivation and of manuring, differs seriously. Beauty of Hebron produces nearly one-sixth more in weight than the New Queen variety, and one-third more than the Clark variety.

Plats 12, 17, 18, 19 and 21, which remained in grass in previous years, received as top-dressing, muriate of potash, 200 pounds, and ground bone, 600 pounds, per acre, at an early date in the spring, 1893. The grass was cut June 27 and 28. As the weeds began to infest the plats, the experiment of studying a variety of grasses was closed, and the sod turned under during the month of August. Dry lands do not favor for any length of time an economical and clean cultivation of the majority of our best grasses. For details, see eleventh annual report for 1893.

A. Observations with Potatoes (1894).

During the present season the experiments of the preceding year with potatoes were repeated, and several varieties of mixed forage crops substituted for the grasses. Beauty of Hebron, Clark's and New Queen were the varieties of potatoes used in the trial, the seed tubers being selected from our crop of the previous year. Beauty of Hebron were grown on plats 12 and 21, New Queen on 17 and 18, and Clark's on 19 and 20. One plat in each case was supplied with potash in the form of muriate of potash (17, 19 and 21), and one in each case in the form of high-grade sulphate of potash (12, 18 and 20).

Fertilizer used.

[Pounds.]

		Per Plat.	Per Acre.
Plats 12, 18, 20,	Sulphate of potash (high grade), .	54	400
	Bone, ...	80	600
Plats 17, 19, 21,	Muriate of potash, ...	54	400
	Bone, ...	80	600

Composition of Fertilizer used.

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone, ...	4.09	–	21.86
Sulphate of potash, ...	–	50.80	–
Muriate of potash, ...	–	52.20	–

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 12, 18, 20, ...	$2 39	$17 80
Plats 17, 19, 21, ...	2 12	15 80

The field was ploughed April 11, the fertilizer was applied broadcast April 20, and harrowed in. The potatoes were planted April 24, at the rate of two and one-half bushels per plat, or nineteen bushels per acre. As far as possible medium-sized whole potatoes were used for seed, and when larger ones were used they were cut in pieces corresponding in size to the former. May 11 the crop began to appear above ground, but was somewhat nipped by the frost of the 15th. The field was cultivated and hoed May 30 and June 18, on which latter date the first appearance of blooming was noticed on the various plats, Beauty of Hebron leading. Owing to the severe drought during the latter part of the growing period, the crop did not turn out as good as at first indicated, there being a serious falling off in yield and an unusually large proportion of small tubers.

YIELD OF CROP (1894).

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 19, Clark's, . . .	870	539	1,409	6,660	4,064	10,724
Plat 17, New Queen, . .	1,161	563	1,724	8,754	4,245	12,999
Plat 21, Beauty of Hebron, .	962	449	1,411	7,253	3,384	10,637

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 19, Clark's, . . .	–	–	–	111	67	178
Plat 17, New Queen, . .	–	–	–	146	70	216
Plat 21, Beauty of Hebron, .	–	–	–	121	56	177

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . . .	741	527	1,268	5,587	3,973	9,560
Plat 18, New Queen, . .	1,183	510	1,693	8,920	3,845	12,765
Plat 12, Beauty of Hebron, .	1,230	511	1,741	9,274	3,853	13,127

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . . .	–	–	–	93	66	159
Plat 18, New Queen, . .	–	–	–	149	64	213
Plat 12, Beauty of Hebron, .	–	–	–	154	64	218

Comparison of Yield for 1893 and 1894.

Total Yield (Bushels per Acre).

	1893.	1894.	Percentage of Decrease.
Clark's, with muriate of potash, . .	209	178	14.84
New Queen, with muriate of potash, .	233	216	7.30
Beauty of Hebron, with muriate of potash,	294	177	19.80
Clark's, with sulphate of potash, . .	222	159	28.38
New Queen, with sulphate of potash, .	257	213	17.12
Beauty of Hebron, with sulphate of potash,	304	218	27.60

Percentage of Marketable Potatoes.

Clark's, with muriate of potash, . .	86.60	62.36	24.24
New Queen, with muriate of potash, .	87.12	67.59	19.53
Beauty of Hebron, with muriate of potash,	91.83	68.36	23.47
Clark's, with sulphate of potash, . .	86.92	58.49	28.43
New Queen, with sulphate of potash, .	90.66	70.00	20.66
Beauty of Hebron, with sulphate of potash,	90.13	70.64	19.49

The crop of 1894 as compared with that of 1893 is in every case smaller, owing to the exceptionally dry season.

The relative proportion of marketable tubers is considerably greater in 1893 than in 1894, owing to a premature cessation of growth during the drought.

The difference in yield of the plats receiving muriate, as compared with those receiving high-grade sulphate of potash, is but slight.

The severe drought has affected results to such an extent that no further conclusions can be drawn with reference to the fertilizer used.

B. Observations with Mixed Forage Crops (1894).

Plats 11, 13, 14, 15 and 16, which were used for the production of potatoes during 1893, were set apart for the raising of mixed forage crops during 1894. Plats 11, 13 and 15 were fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, while plats 14 and 16 were fertilized with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. Vetch, oats and horse bean were raised on Plat 11, vetch and barley on plats 13 and 14 and vetch and oats on plats 15 and 16. The plats were prepared for planting at the same time and in a similar manner as those used for the raising of potatoes.

Vetch and Barley. — Plats 13 and 14 were prepared for the raising of vetch and barley. Plat 13 was fertilized with muriate of potash and bone and Plat 14 with sulphate of potash and bone. The seed was sown April 26, at the rate of 45 pounds vetch and 3 bushels barley per acre. The plants appeared above ground May 4.

Height of Plants on Plats.

[Inches.]

	Plat 13 (Muriate).	Plat 14 (Sulphate).
June 12, ...	20	20
June 18, ...	28	28

The barley began to head out June 20, and June 23 the crop was cut for hay, the vetch being just in bloom. The yield of hay was as follows: —

	Per Plat (Pounds).	Per Acre (Pounds).
Plat 13,.	765	5,737
Plat 14,.	677	5,077

Analyses of Vetch and Barley.

[Equal number of plants of each; collected June 22, 1894.]

	PER CENT.	
	Plat 13.	Plat 14.
Moisture at 100° C.,	78.23	77.70
Dry matter,	21.77	22.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.64	7.80
" fibre,	32.25	32.58
" fat,	2.12	2.56
" protein,	14.44	13.36
Nitrogen-free extract matter,	46.55	43.70
	100.00	100.00

Vetch and Oats. — Plats 15 and 16 were set aside for the raising of vetch and oats. Plat 15 was fertilized with 400 pounds muriate of potash and 600 pounds ground bone per acre, and Plat 16 with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. The land was prepared as for the other plats. The seed was put in April 6, at the rate of 45 pounds vetch and 4 bushels of oats per acre. May 4 the plants appeared above ground.

Height of Plants on Plats.

[Inches.]

	Plat 15 (Muriate).	Plat 16 (Sulphate).
June 12,	20	20
June 18,	26	24
June 26,	33	33

The oats began to head out June 25, and the crop was cut for hay July 2, the vetch being then on the point of blooming. The yield of hay was as follows: —

	Pounds.	
	Per Plat.	Per Acre.
Plat 15,	1,068	8,051
Plat 16,	940	7,088

Analyses of Vetch and Oats.

[Equal number of plants of each; collected July 5, 1894.]

	Per Cent.	
	Plat 15.	Plat 16.
Moisture at 100° C.,	76.24	75.29
Dry matter,	23.76	24.71
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.59	8.69
" fibre,	29.83	31.28
" fat,	3.13	2.63
" protein,	18.88	15.16
Nitrogen-free extract matter,	38.57	42.24
	100.00	100.00

Vetch, Oats and Horse Bean. — Plat 11, which was used for growing the above crop, was fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, the preparation of the plat for the seed being the same as for the other plats. May 8 the seed was sown, at the rate of 60 pounds vetch, 60 pounds horse bean and 136 pounds of oats per acre. On May 16 the vetch and oat plants were coming up, and the horse bean appeared on the 21st.

Height of Plants.

[Inches.]

June 18,	15
June 26,	22

June 28 the horse-bean plants began to bloom, and July 2 the crop was cut. The plat yielded 835 pounds of hay, at the rate of 6,294 pounds per acre.

Analysis of Vetch, Oats and Horse Bean.

[Three plants each of vetch and of oats and one of horse bean; collected July 9, 1894.]

	Per Cent.
Moisture at 100° C.,	82.13
Dry matter,	17.87
	100.00

Analysis of Dry Matter.

Crude ash,	10.36
" fibre,	30.07
" fat,	2.70
" protein,	18.93
Nitrogen-free extract matter,	77.94
	100.00

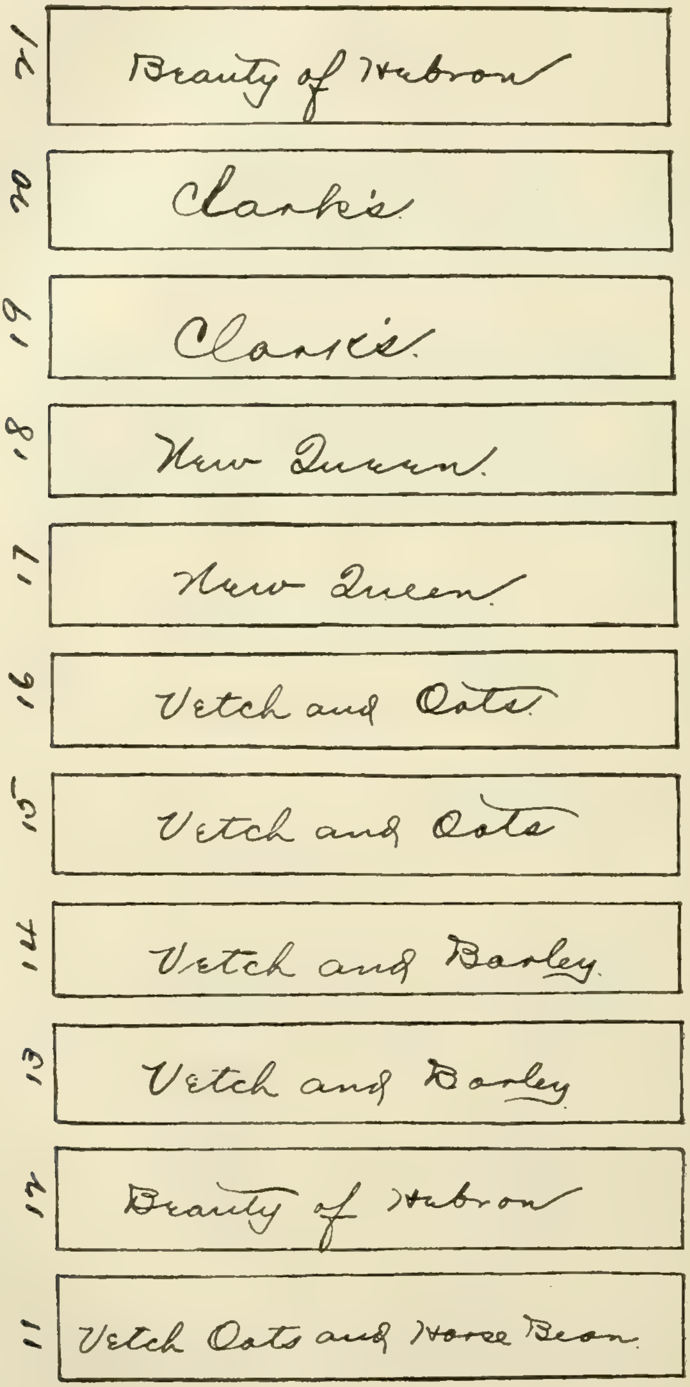
Conclusions.

On the whole, vetch and oats leads vetch and barley, on account of the larger and more foliaceous character of the oats as compared with the barley. Vetch, oats and horse bean leads in nitrogenous matter, and no doubt will exceed in regard to the nutritious character of the crop as soon as the amount of horse bean has been doubled, as indicated above. (Every one of these crops compares well with clover hay.)

The large yield of these crops per acre, their high nutritive value and special adaptation for green fodder, hay or ensilage, merit serious attention for the support of farm and dairy stock.

The early date of maturity presents exceptionally good chances of raising a second crop for fall supply, or for a timely preparation of the soil for winter crops.

Field "B," 1894.


21
Beauty of Hebron
20
Clark's
19
Clark's
18
New Queen
17
New Queen
16
Vetch and Oats
15
Vetch and Oats
14
Vetch and Barley
13
Vetch and Barley
12
Beauty of Hebron
11
Vetch Oats and Horse Bean

Scale, 4 rods to 1 inch.

3. FIELD EXPERIMENTS TO ASCERTAIN THE INFLUENCE OF DIFFERENT MIXTURES OF COMMERCIAL FERTILIZERS ON THE YIELD AND GENERAL CHARACTER OF SEVERAL PROMINENT GARDEN CROPS.

Field C.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size (89½ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of five feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration.

The entire field occupied by the experiment is nearly on a level. Its earlier history can be learned from previous annual reports.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats Nos. 1, 2 and 3 during that of 1892. The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of the manurial substances applied to the different plats: —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

Beets, cabbages, celery, lettuce, spinach, tomatoes and potatoes have thus far been raised upon the field.

The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats: —

1892.

Celery.
Lettuce.
Spinach.
Beets.
Cabbages.
Tomatoes.
Potatoes.

1893.

Spinach.
Celery.
Lettuce.
Red Cabbage.
Beets.
Potatoes.
Beets.
White Cabbage.
Tomatoes.

1894.

Potatoes.
Beans.
Tomatoes.
Spinach.
Lettuce.
Onions.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated essential ingredients of plant food: —

Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

4.1 pounds of nitrogen.
3.9 pounds of potassium oxide.
1.9 pounds of phosphoric acid.

The weights and particular stage of growth of the vegetables when harvested control under otherwise corresponding conditions the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity.

The various mixtures of fertilizers used by us in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil.

1894. — The field was ploughed April 22, and the fertilizer mixtures previously given were applied broadcast the 23d and thoroughly harrowed in. Potatoes, beans, tomatoes, spinach, lettuce and onions were the crops selected for trial in each plat, being arranged as follows, beginning at the west side of each plat: —

Five rows of potatoes (Beauty of Hebron).
Six rows of beans.
Two rows of tomatoes (Essex Hybrid).
Two rows of spinach (New Zealand).
One row of lettuce (Hanson).
Four rows of onions (Yellow Globe Danvers).

Lettuce and tomato plants were raised in the hot-bed and subsequently transferred to the plats. The work of seed sowing and transplanting was done for each particular kind on the same day. April 25 the potatoes were planted, one bushel of seed being used per plat; the spinach and onion seed were put in April 26; the beans on May 7; May 18 the lettuce plants were set out from the hot-bed, and the tomato plants on May 19. The onion plants began to appear May 7; the spinach plants May 9; the potatoes appeared on the 11th, being touched by the frost of the 15th; the beans began to appear May 17, but owing to poor germination on plats 2, 3, 5 and 6 additional seed was put in about the last of May. All crops were kept free from weeds and treated similarly throughout the season. The various crops were harvested whenever fit for the market. A severe drought during the months of July and August affected seriously the yield of crops and the time of harvesting. The subsequent statements give data regarding date of maturity and yield of the different crops.

Yield of Spinach (Variety New Zealand).

Plats.	Pounds.
Plat 1 (two rows), ...	101
Plat 2 (two rows), ...	216
Plat 3 (two rows), ...	165
Plat 4 (two rows), ...	161¾
Plat 5 (two rows).	253
Plat 6 (two rows), ...	113¾

The seed was sown April 26; the crop was harvested July 2.

Yield of Lettuce (Variety Hanson).

Plats.	Perfect Heads.	Pounds.
Plat 1 (one row; eighty-one plants), . . .	45	33¼
Plat 2 (one row; one hundred and two plants), .	97	76¾
Plat 3 (one row; one hundred and six plants), .	81	54½
Plat 4 (one row; one hundred and two plants), .	95	74½
Plat 5 (one row; one hundred and six plants), .	104	98½
Plat 6 (one row; ninety-two plants), . . .	71	43

The plants were set out May 17; they were harvested June 29.

Yield of Potatoes (Variety Beauty of Hebron).

PLATS.	POUNDS.		
	Marketable.	Small.	Total.
Plat 1 (five rows),	205	115	320
Plat 2 (five rows),	240	175	415
Plat 3 (five rows),	220	150	370
Plat 4 (five rows),	220	170	395
Plat 5 (five rows),	195	195	390
Plat 6 (five rows),	240	155	395

The potatoes were planted April 25; they were harvested August 7.

Yield of Beans.

PLATS.	Pounds.
Plat 1 (six rows),	45
Plat 2 (six rows),	32
Plat 3 (six rows),	41
Plat 4 (six rows),	20
Plat 5 (six rows),	37
Plat 6 (six rows),	49

The beans were planted May 7. The germination on plats 2, 3, 5 and 6 was very imperfect, and May 27 extra seed was put in on these plats. June 25 first of plants came into bloom; they were threshed August 17.

Yield of Onions (Variety Yellow Globe Danvers).

PLATS.	Pounds.
Plat 1 (four rows),	156
Plat 2 (four rows),	249
Plat 3 (four rows),	251
Plat 4 (four rows),	256
Plat 5 (four rows),	266
Plat 6 (four rows),	204

The seed was sown April 26; the crop was harvested September 24.

Yield of Tomatoes (Variety Essex Hybrid).

DATE OF HARVESTING.	POUNDS.					
	1.	2.	3.	4.	5.	6.
August 10 (matured),	–	3	10	9	7	8
August 14 (matured),	8	25	12	13	12	12
August 17 (matured),	29	77	40	52	60	31
August 20 (matured),	38	71	82	81	79	69
August 23 (matured),	22	43½	47	41½	48	38
August 27 (matured),	56	77	61	93	74	69
August 31 (matured),	54	70	56	92	76	66
September 4 (matured),	31	45	40	46	50	56
September 10 (matured),	60	68	54	85	112	66
Total weight of matured tomatoes,	298	489	402	512	518	415
September 11 (green),	54	70	56	92	76	56
Total weight of green and matured,	352	559	458	604½	594	571

There were two rows of tomatoes in each plat, with 22 plants in each row. They were set out May 19 and began to bloom June 5.

Potatoes (Variety Beauty of Hebron).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (five rows),	–	585	400	320
Plat 2 (five rows),	–	665	520	415
Plat 3 (five rows),	–	545	390	370
Plat 4 (five rows),	735	640	525	395
Plat 5 (five rows),	780	740	520	390
Plat 6 (five rows),	–	435	580	395

Tomatoes (Variety Essex Hybrid).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (two rows),	–	464	363	352
Plat 2 (two rows),	–	572	874½	559
Plat 3 (two rows),	–	466	807	458
Plat 4 (two rows),	641	515	818	604
Plat 5 (two rows),	647	593	978½	594
Plat 6 (two rows),	–	332	515	571

Lettuce (Variety Hanson).

SEVENTY PLANTS.	1892.	1893.	1894.
Plat 1 (one row), ...	41½	40½	29
Plat 2 (one row), ...	36	42	52
Plat 3 (one row), ...	43	46	36
Plat 4 (one row), ...	76	62	50
Plat 5 (one row), ...	60	70	68
Plat 6 (one row), ...	36	55	33

Spinach (Variety New Zealand).

PLATS.	1892.	1893.	1894.
Plat 1 (two rows), ...	192	167½	101
Plat 2 (two rows), ...	233	182	216
Plat 3 (two rows), ...	202	180½	165
Plat 4 (two rows), ...	230	–	161¾
Plat 5 (two rows), ...	232	210	253
Plat 6 (two rows), ...	134	198½	113¾

From our observations as above reported, extending over three years, we may draw the following conclusions: —

Potash in the form of sulphate has given the most satisfactory results, as compared with muriate, in the case of potatoes, tomatoes, lettuce and spinach, and with onions during the present season.

Nitrogen in the form of nitrate of soda has given us, without regard to the potash source, the most satisfactory returns in case of spinach, lettuce, potatoes and tomatoes, and with onions during the present season.

Lettuce (sampled July 6, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	96.93	96.97
Dry matter,	3.07	3.03
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	17.84	15.66
" fibre,	13.35	14.11
" fat,	3.36	3.44
" protein,	23.83	26.85
Nitrogen-free extract matter,	41.62	39.94
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	96.930	96.970
Calcium oxide,	.026	.026
Magnesium oxide,	.005	.003
Sodium oxide,	.015	.018
Potassium oxide,	.241	.233
Phosphoric acid,	.017	.036
Nitrogen,	.117	.130
Insoluble matter,	.124	.104

Spinach (sampled July 12, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.80	91.63
Dry matter,	7.20	8.37
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	29.47	29.06
" fibre,	12.49	11.77
" fat,	2.42	2.12
" protein,	25.45	28.53
Nitrogen-free extract matter,	30.17	28.52
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.800	91.630
Calcium oxide,	.054	.065
Magnesium oxide,	.049	.052
Sodium oxide,	.199	.230
Potassium oxide,	.838	1.076
Phosphoric acid,	.046	.055
Nitrogen,	.293	.382
Insoluble matter,	.273	.272

Beets.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	79.54	82.91
Dry matter,	20.46	17.09
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	5.46	5.72
" fibre,	5.68	5.88
" fat,	.33	.36
" protein,	14.56	13.59
Nitrogen-free extract matter,	73.97	74.45
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	79.540	82.910
Calcium oxide,	.143	.077
Magnesium oxide,	.031	.025
Sodium oxide,	.098	.125
Potassium oxide,	.524	.450
Phosphoric acid,	.136	.113
Nitrogen,	.476	.368
Insoluble matter,	.109	.106

Cabbage.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.95	93.74
Dry matter	7.05	6.26
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.76	6.80
" fibre,	15.69	14.57
" fat,	1.95	2.46
" protein,	3.16	3.85
Nitrogen-free extract matter,	69.44	72.32
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.950	93.740
Calcium oxide,	.026	.024
Magnesium oxide,	.010	.010
Sodium oxide,	.040	.029
Potassium oxide,	.363	.299
Phosphoric acid,	.017	.036
Nitrogen,	.223	.241
Insoluble matter,	.217	.165

Tomatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	93.51	94.44
Dry matter,	6.49	5.56
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.99	7.18
" fibre,	9.71	9.40
" fat,	4.96	4.95
" protein,	16.57	20.85
Nitrogen-free extract matter,	60.77	57.62
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	93.510	94.440
Calcium oxide,	.030	.024
Magnesium oxide,	.019	.014
Sodium oxide,	–*	–*
Potassium oxide,	.353	.356
Phosphoric acid,	.045	.039
Nitrogen,	.170	.185
Insoluble matter,	.011	.021

* Not determined.

Potatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	80.71	81.17
Dry matter,	19.29	18.83
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.71	4.64
" fibre,	2.26	2.35
" fat,	.54	.42
" protein,	10.98	10.06
Nitrogen-free extract matter,	81.51	82.53
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	80.710	81.170
Calcium oxide,	.018	.020
Magnesium oxide,	.044	.041
Sodium oxide,	.029	.024
Potassium oxide,	.607	.553
Phosphoric acid,	.065	.048
Nitrogen,	.338	.303
Insoluble matter,	.026	.048

Field C, Eastern Portion.

The part of Field C east of the experiment plats is 183 by 131 feet, and contains .55 acre, being divided into two equal portions by the strip of uncultivated land passing through the centre of the field. The fertilizer applied consisted of 300 pounds of fine-ground bone and 100 pounds of muriate of potash. A strip 20 feet wide was set off at the western side of the portion for special trials with vegetables, etc. The northern portion remaining was used for the production of carrots and the southern portion for globe mangolds. In both cases the seed was put in May 4 and the young plants appeared above ground the 14th. The field was kept free from weeds during the growing season, and the mangolds were harvested on October 9, yielding 3,840 pounds of roots, or 15,368 pounds per acre. The carrots were harvested October 11, giving 5,563 pounds, or 22,363 pounds per acre. The space west of the mangolds was used for trials with oats. Three varieties, sent on by J. A. Everett, Indianapolis, Ind., were tested. They were: No. 1, Colgarry Gray; No. 2, Rust Proof; and No. 3, White Superior Scotch. Two rows of each (89 feet long) were planted. The oats were sown in drills May 4 and germinated May 10.

Height of Oats.

[Inches.]

	June 5	June 12.	June 26.	July 3.
No. 1, Colgarry Gray, ...	8	15	23	30
No. 2, Rust Proof, ...	7	12	18	20
No. 3, White Superior Scotch, ...	9	15	26	30

The oats were somewhat affected by rust during the season, No. 2 suffering more than the others. June 29 the oats began to head out. Nos. 1 and 3 were cut July 16; No. 2, several days later.

Yield of Oats.

[Pounds.]

	Total Weight.	Grain.	Straw.	Per Cent. of Grain.
No. 1, Colgarry Gray,	38	15	23	39.50
No. 2, Rust Proof,	43	4½	38½	10.40
No. 3, White Superior Scotch,	41	7½	33½	18.30

The space west of the carrots was given to the raising of peas, Wisconsin tree bean, bush lima bean and potatoes. The peas were sent on for trial by James J. H. Gregory & Son, Marblehead, Mass., and were numbered 1, 2 and 3, there being one row of each. They were planted May 4, coming up about the 11th. June 11 No. 1 began to bloom, and June 14 Nos. 2 and 3, the different rows having then the following heights: —

	Inches.
No. 1,	12
No. 2,	6
No. 3,	11

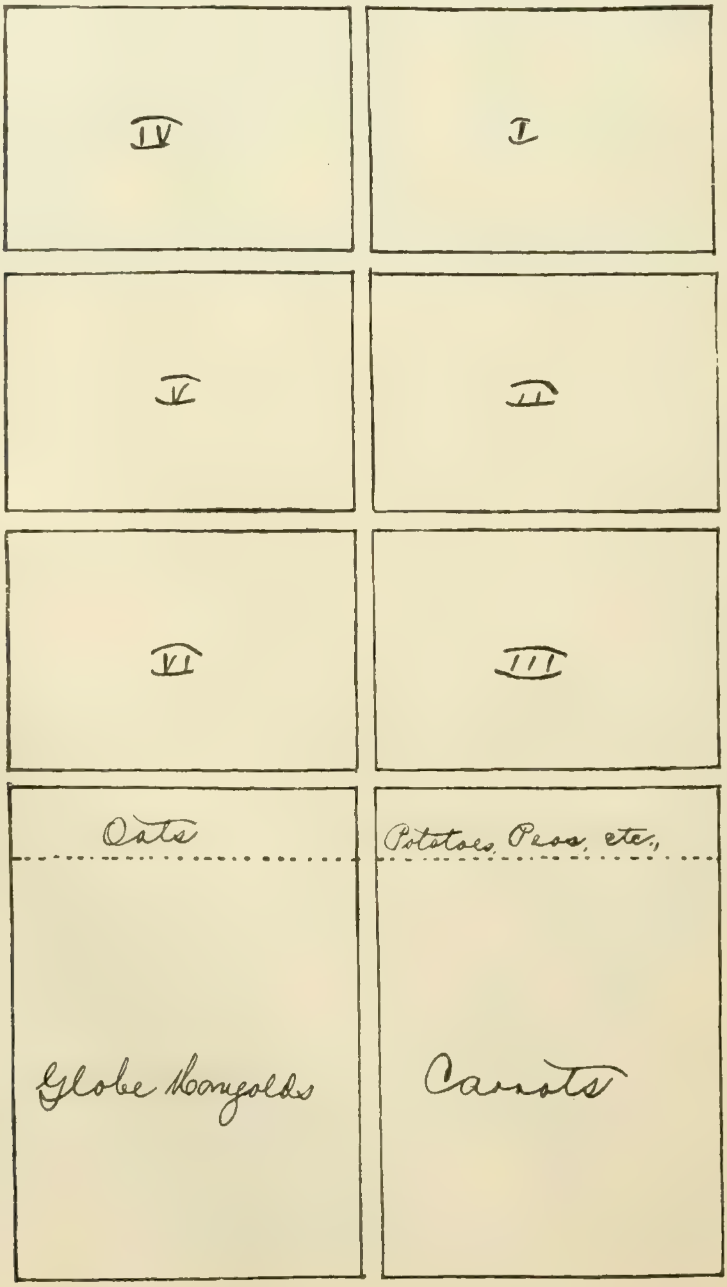
June 25 there were pods ready for picking on No. 1; June 29, on No. 2, with a few on No. 3. No. 1 proved to be the best yielder.

West of the peas was one row each of bush lima beans and Wisconsin tree beans. The lima beans were sent on by the United States Department of Agriculture and the Wisconsin tree beans by J. A. Everett. The Wisconsin tree beans came into bloom June 25 and the bush lima beans on July 9, but the latter failed to reach maturity.

The remaining row was planted to a variety of potatoes, Nos. 1–6 of which were sent on by J. A. Everett, Indianapolis, Ind., and No. 7 by Richard Nott, Burlington, Vt. They were planted May 4, and May 17 No. 1 began to appear; Nos. 2, 3, 5 and 6 on the 20th; No. 7 on the 23d and No. 4 on the 24th. July 5 Nos. 1, 2, 3 and 6 were noted as coming into bloom, the others being a little later. August 22 the tubers were dug, and yielded as follows: —

No.	NAME.	No. of Hills.	No. of Tubers.	Total Weight.	Market-able Tubers	Weight.	Small Tubers.	Weight.
				lbs. oz.		lbs. oz.		lbs. oz.
1	Early Everett, . .	5	68	10 14	34	7 12	34	3
2	Rural New Yorker, .	6	53	9 12	39	8 10	14	1 4
3	Colossal, . . .	7	74	13 12	43	10 12	31	3
4	Heavy Weight, . .	6	77	7 14	15	3	62	4 14
5	Everett's Six Weeks,	5	64	5 11	16	2 13	48	2 14
6	Green Mountain, .	6	68	12 4	40	9 15	28	2 5
7	Nott's Seedling No. 7,	2	19	3 9	13	3 3	6	6

Field "C," 1894.


IV
I
V
II
VI
III
Oats
Potatoes, Peas, etc.,
Globe Mangolds
Carrots

Scale, 4 rods to 1 inch.

4. EXPERIMENTS WITH FORAGE CROPS (TWENTY-SEVEN).

Field D.

This field has been used for the past three years for the raising of a variety of reputed annual and perennial fodder crops, in the majority of cases new to our section of the country, to study their adaptation to our climate and soil. Some of them have since been raised on a larger scale successfully and profitably for the support of our dairy stock, as southern cow-pea, serradella, early-maturing soja bean, late-maturing soja bean, summer vetch and oats, summer vetch and barley, and vetch, oats and horse bean.

The field is 328 feet long and 70 feet wide, covering an area of 22,960 square feet, or .527 acre. The field was ploughed April 30, and May 1 a fertilizer mixture was applied at the rate of 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The fertilizer was applied broadcast and harrowed in. The different crops were planted in rows two and one-half feet apart, and were kept free from weeds throughout the season. They were arranged in the field during the past season in the following order, beginning at the west end: —

Prickly comfrey (*Symphytum officinalis*).
Alfalfa (*Medicago sativa*).
Kidney vetch (*Anthyllis vulneraria*).
Forest pea or flat pea (*Lathyrus sylvestris*).
Crimson clover (*Trifolium incarnatum*).
Alsike clover (*Trifolium hybridum*).
Medium red clover (*Trifolium medium*).
Sainfoin (*Onobrychis sativa*).
Japanese clover (*Lespedeza striata*).
Winter rape (*Brassica napus*).
Dwarf Essex rape (*Brassica napus*).
Serradella (*Ornithopus sativus*).
Vetch (*Vicia sativa*).
Bokhara clover (*Melilotus alba*).
Yellow lupine (*Lupinus lutens*).
Blue lupine (*Lupinus perennis*).
White lupine (*Lupinus alba*).
Southern cow-pea (*Dolichos sinensis*).

Horse bean (*Vicia faba*).
Early-maturing soja bean (*Soja hispida*).
Late-maturing soja bean (*Soja hispida*).
Silver-hull buckwheat (*Fagopyrum esculentum*).
Japanese buckwheat (*Fagopyrum esculentum*).
Common buckwheat (*Fagopyrum esculentum*).
Hog millet.
Golden wonder millet.
Spanish peanut.

Prickly comfrey (*Symphytum officinalis*), one row. The roots remained in the ground and wintered well during the winter of 1893–94, but were moved to their present position before the field was ploughed during the spring. The crop made a good growth, coming into bloom June 1. June 14 a part of it was cut for feeding (containing 86.67 per cent. moisture); the remainder was cut June 21. A second growth was made, which was cut during the fall. Following is given the analysis of the crop: —

	Per Cent.
Moisture at 100° C.,	86.67
Dry matter,	13.33
	100.00

Analysis of Dry Matter.

Crude ash,	21.12
“ fibre,	11.03
“ fat,	2.06
“ protein,	17.49
Nitrogen-free extract matter,	48.00
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	86.79
Dry matter contains: —	
Nitrogen,	2.80
Potassium oxide,	5.76
Phosphoric acid,	.87

This plant has been recommended as a forage crop for dairy stock which can be grown upon lands where leguminous crops fail to give satisfactory results.

Alfalfa (*Medicago sativa*), five rows. The seed was purchased of J. M. Thorburn & Co., New York, at twenty cents per pound. The seed was sown May 10, appearing above ground May 17. The plants were twelve inches high July 3, fourteen inches high July 10. They suffered greatly from the effects of the dry weather. Following is an average analysis of the crop as hay: —

	Per Cent.
Moisture at 100° C.,	9.60
Dry matter,	91.40
	100.00

Analysis of Dry Matter.

Crude ash,	8.11
" fibre,	29.72
" fat,	1.65
" protein,	14.22
Nitrogen-free extract matter,	46.20
	100.00
Dry matter contains: —	
Nitrogen,	2.21
Potassium oxide,	1.55
Phosphoric acid,	.56

We have experimented with alfalfa at different times during the existence of the station, as will be noted from previous annual reports, with but little encouragement, as the crop suffered seriously from winter-killing.

Kidney vetch (*Anthyllis vulneraria*), five rows. The seed was sown May 10, the plants appearing May 25. Being a perennial, the growth of the present season was but slight. Below is given an analysis of the second growth, cut when in bloom: —

	Per Cent.
Moisture at 100° C.,	80.85
Dry matter,	19.15
	100.00

Analysis of Dry Matter.

Crude ash,	13.28
" fibre,	14.94
" fat,	3.51
" protein,	18.43
Nitrogen-free extract matter,	48.94
	100.00
Dry matter contains: —	
Nitrogen,	2.94
Potassium oxide,	1.75
Phosphoric acid,	.44

This plant prospers particularly upon a sandy soil, where other leguminous plants fail to give satisfactory returns. Its cultivation has of late received considerable attention in leading agricultural districts of Europe, for the above reason.

Flat pea or forest pea (*Lathyrus sylvestris*), six rows. Four rows remained in the ground from last season, but, having winter-killed somewhat, they were combined into two. On May 10 four rows were sown with seed obtained of Delano Bros., Lee Park, Neb. The young plants began to appear above ground June 6. The two rows of older plants made a good growth, coming into bloom June 18. It was cut July 12 for feeding, having then formed a number of pods. The sample for analysis was taken at this time: —

	Per Cent.
Moisture at 100° C.,	78.80
Dry matter,	21.20
	100.00

Analysis of Dry Matter.

Crude ash,	9.35
" fibre,	28.27
" fat,	3.29
" protein,	27.26
Nitrogen-free extract matter,	31.83
	100.00

Dry matter contains: —

Nitrogen,	4.36
Potassium oxide,	2.57
Phosphoric acid,	.90

Our results thus far obtained are not encouraging as far as adaptation to our clime and soil is concerned. The plant grows slowly during its earlier period, and has suffered repeatedly from winter-killing. Its high nutritive value may be judged from the above analysis. Whether it is acceptable to dairy stock as green fodder is somewhat in question. Judging from the observations of others, its best use is as silage.

Crimson clover (*Trifolium incarnatum*), six rows. The seed was sown May 10, appearing above ground the 15th. The growth during the early part of the season was promising, but the dry weather made practically a failure of it as far as yield was concerned. The seed was purchased of J. M. Thorburn & Co., New York, at twelve and one-half cents per pound. As the crop had suffered from the drought considerably when reaching its maturity, the analysis was left for another season.

Alsike clover (*Trifolium hybridum*), six rows. The seed was sown May 10, the young plants beginning to appear above ground May 17. This crop was also seriously affected by the drought. The seed was obtained of J. M. Thorburn & Co., New York, at 25 cents per pound. An average analysis of the dry material is given below: —

	Per Cent.
Moisture at 100° C.,	9.93
Dry matter,	90.07
	100.00

Analysis of Dry Matter.

Crude ash,	11.90
" fibre,	26.17
" fat,	2.58
" protein,	16.63
Nitrogen-free extract matter,	42.72
	100.00
Dry matter contains: —	
Nitrogen,	2.48
Potassium oxide,	2.47
Phosphoric acid,	.74

This variety of clover has served us well in our meadows, it being seeded every two years at the rate of three to four pounds per acre, applied in the spring.

Medium red clover (*Trifolium medium*), five rows. The seed was sown May 10, first appearing above ground May 17. The crop did not make sufficient growth, on account of the dry weather, so that it was not cut. The seed was purchased of J. M. Thorburn & Co., New York, at fifteen cents per pound. Below is given an analysis of the dry fodder: —

	Per Cent.
Moisture at 100° C.,	11.41
Dry matter,	88.59
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	9.84
" fibre,	27.51
" fat,	2.13
" protein,	15.75
Nitrogen-free extract matter,	44.77
	100.00
Dry matter contains: —	
Nitrogen,	2.37
Potassium oxide,	2.48
Phosphoric acid,	.48

As this is the standard variety of clover for use on grass lands, no further discussion with regard to its merits is needed.

Sainfoin (*Onobrychis sativa*), four rows. The sainfoin remained in the ground from last year, the five rows being reduced to four. It started into growth well, and May 19 had commenced to bloom. It was sampled for analysis on May 28 and June 7, being cut for feeding June 11, when thirty inches high. It made a very good second growth, coming into bloom July 17.

	May 28 (Per Cent.).	June 7 (Per Cent.).
Moisture at 100° C.,	79.49	76.27
Dry matter,	20.51	23.73
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.06	9.56
" fibre,	22.62	22.49
" fat,	2.83	2.78
" protein,	15.95	18.11
Nitrogen-free extract matter,	50.55	47.06
	100.00	100.00

Fertilizing Constituents.

	Per Cent.
Moisture at 100° C.,	12.17
Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	2.29
Phosphoric acid,	.86

This crop requires a calcareous soil and dry subsoil to do its best.

Japanese clover (*Lespedeza striata*), five rows. Seed sown May 10, first appearing above ground June 1. Being a perennial, the plant did not make sufficient growth to permit of an analysis. The seed was sent on by the United States Department of Agriculture.

Winter rape (*Brassica napus*), five rows. The seed was sown May 10, the young plants appearing above ground May 15. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa. July 6 a portion of the rape was cut and fed out, being about fourteen inches high. Analysis at this period: —

	Per Cent.
Moisture at 100° C.,	83.34
Dry matter,	16.66
	100.00

Analysis of Dry Matter.

Crude ash,	22.44
" fibre,	12.26
" fat,	3.06
" protein,	15.16
Nitrogen-free extract matter,	47.08
	100.00

Dwarf Essex rape (*Brassica napus*), five rows. The seed was sown May 10, appearing above ground May 17. It made a good growth. July 6 one row was cut for feeding, being twenty-three inches high at the time. Analysis of a sample taken at this time showed it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	94.57
Dry matter,	5.43
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	16.11
" fibre,	18.96
" fat,	3.80
" protein,	12.86
Nitrogen-free extract matter,	42.27
	100.00

Both varieties of rape are known as valuable fodder plants, as well as suitable crops for green manuring. Neither of these varieties come to blooming during the present season. They are expected to furnish valuable green fodder during the coming season.

Serradella (*Ornithopus sativus*), five rows. The seed was sown May 10, the plants appearing above ground May 21. The crop made a good growth, coming into bloom July 5. July 10 the plants were eleven inches high. The seed was purchased of Henry Nungesser, New York, at ten cents per pound. Following is given an average of the analyses of serradella made at the station: —

	Per Cent.
Moisture at 100° C.,	82.41
Dry matter,	17.59
	100.00

Analysis of Dry Matter.

Crude ash,	10.99
" fibre,	30.08
" fat,	2.41
" protein,	15.01
Nitrogen-free extract matter,	41.51
	100.00

Fertilizing Constituents.

Dry matter contains: —

Nitrogen,	2.40
Potassium oxide,	.70
Phosphoric acid,	.84

We have used serradella for several years as a fodder crop for green fodder as well as silage. It has been raised in drills three feet six inches apart, yielding nine and one-half tons of green fodder per acre.

Spring vetch (*Vicia sativa*). The vetch was sown April 26, the seed coming up May 4. Seed was used at the rate of forty-five pounds per acre. The vetch came into bloom June 23, when twenty-eight inches high. The seed was purchased of J. M. Thorburn & Co., New York, at seven cents per pound. Analysis of the dried crop shows it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	9.90
Dry matter,	91.10
	100.00

Analysis of Dry Matter.

Crude ash,	8.24
" fibre,	30.27
" fat,	2.50
" protein,	15.09
Nitrogen-free extract matter,	43.80
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.21
Dry matter contains: —	
Nitrogen,	2.40
Phosphoric acid,	.86
Potassium oxide,	3.00

Bokhara clover (*Melilotus alba*), five rows. This crop remained in the ground from last year. It started into growth early, and on May 28 about twelve feet from the north end of each of the rows was cut for feeding, being about thirty inches high. June 7 another portion was cut for feeding, being thirty-six inches in height. June 18 the plants were coming into bloom at forty-five inches in height. June 22 the remaining portion was cut and fed out, being five feet in height. The seed was bought of Henry Nungesser, New York, at twenty cents per pound. Analysis of the crop collected at different dates gave the following results: —

	PER CENT.		
	May 28.	June 7.	June 22
Moisture at 100° C.,	87.43	80.99	75.86
Dry matter,	12.51	19.01	24.14
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	11.67	10.21	7.71
" fibre,	24.43	29.98	33.99
" fat,	3.51	2.76	2.88
" protein,	23.37	18.62	17.18
Nitrogen-free extract matter,	37.02	38.43	38.24
	100.00	100.00	100.00

This crop furnishes a liberal amount of fodder the first and second years. It should be cut before the plant reaches blooming, to preserve its succulent character. When advanced beyond that stage of growth it becomes coarse and is rejected by cattle.

Yellow lupine (*Lupinus lutens*), six rows. The seed was sown May 9, coming up May 23, but not germinating very well. July 12 the plants were coming into bloom, being about one foot in height. The seed was obtained of D. Landreth & Son, Philadelphia. Analysis of the plant shows it to have the following composition : —

	Per Cent.
Moisture at 100° C.,	86.05
Dry matter,	13.95
	100.00
Analysis of Dry Matter.	
Crude ash,	11.14
" fibre,	27.10
" fat,	1.87
" protein,	17.84
Nitrogen-free extract matter,	42.05
	100.00

Fertilizing Constituents.

Dry matter contains: —	Per Cent.
Nitrogen,	2.66
Potassium oxide,	2.96
Phosphoric acid,	.61

Blue lupine (*Lupinus cœruleus*), three rows. The seed was sown May 9, the plants appearing above ground May 19. The plants came into bloom July 12, when about two feet in height. The seed was obtained of J. M. Thorburn, New York, at fifteen cents per pound.

White lupine (*Lupinus albus*), six rows. The seed was sown May 9, the young plants appearing above ground May 19. The plants came into bloom June 28. July 10 it was noted as being twenty-five inches high. The seed was purchased of D. Landreth & Son, Philadelphia, at six cents per pound. The composition of the plant is stated below: —

	Per Cent.
Moisture at 100° C.,	85.35
Dry matter,	14.65
	100.00

Analysis of Dry Matter.

Crude ash,	5.03
" fibre,	31.18
" fat,	2.41
" protein,	18.71
Nitrogen-free extract matter,	42.67
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	1.73
Phosphoric acid,	.35

The lupines have served us well as green manuring crops. They may be seeded the beginning of May and are ready to be ploughed under the beginning of June, or may be seeded the latter part of August and are ready for ploughing under the latter part of September.

Southern cow-pea (*Dolichos sinensis*), five rows. The seed was sown May 9, the young plants appearing above ground May 19. The crop made a good growth, and was sampled for analysis on August 28 and October 2. The seed was purchased of D. Landreth & Son, Philadelphia. The analysis of the crop showed the following composition: —

	August 28 (Per Cent.).	October 2 (Per Cent.).
Moisture at 100° C.,	81.81	80.60
Dry matter,	18.19	19.40
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	11.20	9.96
" fibre,	17.87	20.52
" fat,	4.63	3.81
" protein,	17.19	16.41
Nitrogen-free extract matter,	49.11	49.30
	100.00	100.00

Two prominent varieties (Clay and Whippoorwill) have been raised successfully for a number of years, and have served us well as fodder crops either green or in the form of silage. None of these varieties mature seed in our section of the country.

Horse bean (*Vicia faba*), five rows. The seed was sown May 9, and first appeared above ground May 21. The plants first began to blossom June 28. July 10 the plants had reached a height of twenty-one inches. Below is given an analysis of the crop with pods forming: —

	Per Cent.
Moisture at 100° C.,	84.83
Dry matter,	15.17
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	5.75
" fibre,	28.17
" fat,	2.31
" protein,	16.68
Nitrogen-free extract matter,	47.09
	100.00

Horse bean stands our climate extremely well, the medium-sized variety seeming to be the best for us. We have during the past year raised it as a mixed crop with vetch and oats, and are pleased with the results.

Early-maturing soja bean (*Soja hispida*), raised on Field A. The seed was planted May 12, in drills two and one-half feet apart, at the rate of sixty pounds per acre. The young plants began to appear May 21. July 24 the plants on the different plats began to bloom. The yield of the crop was affected considerably by the dry weather. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage. Below is given the analysis of the above crop: —

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.

Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Later-maturing soja bean (*Soja hispida*), five rows. The seed was sown May 9, the young plants first appearing above ground May 21. The crop made a very vigorous growth, and was sampled for analysis at two different periods. The seed was obtained of J. M. Thorburn & Co., New York. The results of the examination of the samples collected are as follows: —

	August 28 (Per Cent.).	October 28 (Per Cent.).
Moisture at 100° C.,	70.91	68.11
Dry matter,	29.09	31.89
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	10.34	8.43
" fibre,	21.09	21.20
" fat,	3.11	2.34
" protein,	27.49	23.16
Nitrogen-free extract matter,	37.97	44.84
	100.00	100.00

Fertilizing Constituents.

Dry matter contains: —		
Nitrogen,	4.39	3.70
Potassium oxide,	–*	–*
Phosphoric acid,	–*	–*

* Not determined.

The above samples were raised on Field A, in 1892, in drills two and one-half feet apart, using seventy pounds of seed per acre, and securing on an average nine to ten tons per acre, which served as mixed ensilage with corn. The addition of leguminous plants, as clover, soja beans, serradella, etc., to corn for silage tends to counteract the acid reaction of the corn silage and furnishes a most acceptable article for feeding.

Silver-hull buckwheat (*Fagopyrum esculentum*), eight rows. The seed was sown May 9, the young plants appearing above ground May 16. It came into bloom June 18, and was cut for feeding out July 14, when about three feet in height. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. An analysis of the dried crop, cut when in bloom, gave the following results: —

	Per Cent.
Moisture at 100° C.,	8.91
Dry matter,	91.09
	100.00

Analysis of Dry Matter.

Crude ash,	10.17
" fibre,	27.07
" fat,	2.55
" protein,	12.22
Nitrogen-free extract matter,	47.99
	100.00

Fertilizing Ingredients.

Dry matter contains: —

Nitrogen,	1.95
Potassium oxide,	2.61
Phosphoric acid,	.94

Japanese buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 16. The first blossoms appeared June 18, and the crop was cut for green fodder July 14. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. Below is given an analysis of the air-dried material, collected when in bloom: —

	Per Cent.
Moisture at 100° C.,	5.71
Dry matter,	94.29
	100.00

Analysis of Dry Matter.

Crude ash,	12.36
" fibre,	36.02
" fat,	2.22
" protein,	10.80
Nitrogen-free extract matter,	38.60
	100.00

Fertilizing Constituents.

Dry matter contains: —

Nitrogen,	1.72
Potassium oxide,	3.51
Phosphoric acid,	.90

Both the silver-hull and Japanese varieties of buckwheat are on the whole larger plants and more foliaceous, and consequently yield a larger amount per acre. The Japanese variety seems to be the better of the two.

Common buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 18. June 18 the plants came into bloom. July 13 the crop was cut and fed out. The seed was obtained of D. Landreth & Son, Philadelphia, at five cents per pound. Below is given an analysis of the dried material: —

	Per Cent.
Moisture at 100° C,	8.50
Dry matter,	91.50
	100.00

Analysis of Dry Matter.

Crude ash,	14.63
" fibre,	19.35
" fat,	3.04
" protein,	17.90
Nitrogen-free extract matter,	45.08
	100.00

Fertilizing Constituents.

Dry matter contains: —

Nitrogen,	2.866
Potassium oxide,	3.504
Phosphoric acid,	.547

Common buckwheat yields somewhat less than the previously mentioned varieties, yet its nutritive character, under a corresponding system of cultivation and manuring, exceeds that of either one.

Hog millet, five rows. The seed was sown May 9, and began to come up May 17. This variety did not make as satisfactory growth as the next. It commenced to head out July 10, when twenty-four inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

Golden wonder millet, five rows. The seed was sown May 9, and began to come up May 17. The crop made a very good growth, and July 9 began to head out, when twenty-six inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

The millets both yield a large crop, but, as the seed was somewhat mixed, no weights have been taken.

Spanish peanut (*Arachis hypogæa*), two rows. The peanuts were planted May 10, coming into bloom July 16. As the amount of seed received and used was small, no data are given with regard to yield, etc. The peanuts were sent on by the United States Department of Agriculture.

We have seeded down during the early part of September, 1894, rye, winter vetch and rye and dwarf Essex rape, to secure, if possible, a supply of valuable green fodder during the middle or latter part of May. The winter vetch used for this purpose was especially imported, to test its adaptation to our climate. Previous experiments in this direction failed, as we suppose, on account of getting summer vetch in place of winter vetch.

Field "D." — Arrangement of Crops raised.

1892.

- Artichoke.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Stachy's Tubers.
- Kidney Vetch.
- Winter Rape.
- Sainfoin.
- Yellow Trefoil.
- Spring Vetch.
- Bokhara Clover.
- Summer Rape.
- Horse Bean.
- Serradella.
- Soja Bean.
- Cow-pea.
- Jackson Wonder Bean.
- Blue Lupine.
- White Lupine.
- Yellow Lupine.
- Silver-hull Buckwheat.
- Japanese Buckwheat.
- Common Buckwheat.

W

E

1893.

- Minnesota Corn.
- White Lupine.
- Yellow Lupine.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Late Soja Bean.
- Kidney Vetch.
- Early White Soja Bean.
- Sainfoin.
- Early Black Soja Bean.
- Cow-pea.
- Serradella.
- Spring Vetch.
- Bokhara Clover.
- Horse Bean.
- Kaffir Corn.
- Common Buckwheat.
- Japanese Buckwheat.
- Silver-hull Buckwheat.
- Summer Rape.
- Carrots.

W

E

1894.

- Prickly Comfrey.
- Alfalfa.
- Kidney Vetch.
- Lathyrus sylvestris.
- Crimson Clover.
- Alsike Clover.
- Medium Red Clover.
- Sainfoin.
- Japanese Clover.
- Winter Rape.
- Essex Rape.
- Serradella.
- Bokhara Clover.
- Yellow Lupine.
- Blue Lupine.
- White Lupine.
- Southern Cow-pea.
- Horse Bean.
- Late Soja Bean.
- Silver-hull Buckwheat.
- Japanese Buckwheat.
- Common Buckwheat.
- Hog Millet.
- Golden Wonder Millet.
- Spanish Peanut.

Scale of length, 50 feet to 1 inch.

Compilation of Analyses of Fodder Articles raised (1894).

NAME OF CROP.	Dry Matter.	100 PARTS OF DRY MATTER CONTAIN —					DRY MATTER CONTAINS —		
		Ash.	Fibre.	Fat.	Protein.	Nitrogen-free Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
I. Leguminous Plants.									
Flat pea (*Lathyrus sylvestris*), ...	21.20	9.35	28.27	3.29	27.26	31.83	4.36	.90	2.57
Late-maturing soja bean, .	29.09	10.34	21.09	3.11	27.49	37.97	4.39	–	–
Late-maturing soja bean, .	31.89	8.43	21.20	2.34	23.18	44.84	3.70	–	–
Early-maturing soja bean, .	34.02	9.69	17.28	2.96	20.13	49.94	3.22	–	–
Bokhara clover, . . .	12.57	11.67	24.43	3.51	23.37	37.02	3.73	–	–
Bokhara clover, . . .	19.01	10.21	29.98	2.76	18.62	38.43	2.97	–	–
Bokhara clover (in bloom),	24.14	7.71	33.99	2.88	17.18	38.24	2.90	–	–
Kidney vetch, . . .	19.15	13.28	14.94	3.51	18.43	48.94	2.94	.44	1.75
White lupine, . . .	14.65	5.03	31.18	2.41	18.71	42.67	2.99	.35	1.73
Yellow lupine, . . .	13.95	11.14	27.10	1.87	17.84	42.05	2.66	.61	2.96
Southern cow-pea, . .	18.19	11.20	17.87	4.63	17.19	49.11	2.75	.58	1.04
Alsike clover, . . .	90.07	11.90	26.17	2.58	16.63	42.72	2.48	.74	2.47
Medium red clover, . .	88.59	9.84	27.51	2.13	15.75	44.77	2.37	.48	2.48
Sainfoin, ...	23.73	9.56	22.49	2.78	18.11	47.06	2.99	.86	2.29
Spring vetch, . . .	91.10	8.24	30.27	2.50	15.09	43.80	2.40	.86	3.00
Serradella, ...	17.59	10.99	30.08	2.41	15.01	41.51	2.40	.84	.70
Alfalfa, ...	91.40	8.11	29.72	1.65	14.22	46.20	2.21	.56	1.55
II. Miscellaneous Crops.									
Common buckwheat, . .	91.50	14.63	19.35	3.04	17.90	45.08	2.87	.55	3.50
Silver-hull buckwheat, .	91.09	10.17	27.07	2.55	12.22	47.99	1.95	.94	2.61
Japanese buckwheat, . .	94.29	12.36	36.02	2.22	10.80	38.60	1.72	.90	3.51
Prickly comfrey, . .	13.33	21.12	11.03	2.06	17.49	48.00	2.80	.87	5.76
Dwarf Essex rape, . .	5.43	16.11	18.96	3.80	12.86	42.27	2.05	–	–
Winter rape, . . .	16.66	22.44	12.26	3.06	15.16	47.08	2.42	–	–

NAME OF CROP.	Dry Matter.	DRY MATTER CONTAINS —				
		Crude Ash.	Crude Fibre.	Crude Fat.	Crude Protein.	Nitrogen-free Extract Matter.
III. Mixed Crops (Dried).						
Vetch and oats, Field G, 1894, ...	91.05	4.48	27.78	2.62	22.56	42.56
Vetch and oats, Field B, Plat 15, 1894, . .	90.64	9.59	29.83	3.13	18.88	38.57
Vetch and oats, Field B, Plat 16, 1894, . .	90.65	8.69	31.28	2.63	15.16	42.24
Vetch and barley, Field B, Plat 13, 1894, . .	91.51	4.64	32.25	2.12	14.44	46.55
Vetch and barley, Field B, Plat 14, 1894, . .	90.76	7.80	32.58	2.56	13.36	43.70
Vetch, oats and horse bean, Field B, Plat 11, 1894, ...	89.81	10.36	30.07	2.70	18.93	77.94

The raising of fodders richer in nitrogenous constituents than our meadow growth (upland meadow hay) and pasture growth enables us to reduce the expenses for commercial concentrated feed stuffs to produce the desired well-balanced nutritive fodder rations for our farm live stock.

How can Forage Crops assist in improving the Productiveness of our Farm Lands?

The consideration of this important question claims the serious attention of every thinking and progressive farmer, for nobody questions the correctness of the view that a successful termination of his work depends in a controlling degree on a correct appreciation of the extent and character of his resources of plant food and on a liberal and intelligent use of the latter.

An insufficient supply of suitable manurial matter, required for the successful and liberal production of the crops to be raised, is at present universally recognized as being the most fatal circumstance in any system of farming for profit. Adopting this conclusion as the correct verdict of past and present experience in agricultural industries, it becomes most desirable, in the interest of satisfactory pecuniary returns, that every available manurial resource of the farm should be turned to account to its full extent. *To secure this end we are advised to begin the work with a timely thorough mechanical preparation of the soil under cultivation; to select the crops to be raised, as far as practicable, with reference to their tendency of economizing existing natural resources of plant food; to increase the latter to the full extent of suitable home-made manure on hand, and to supplement the latter liberally by buying commercial concentrated fodder articles and commercial fertilizer, as far as circumstances advise.*

To again discuss * briefly one of the means of developing and economizing manurial sources of the farm is the object of this chapter.

On Production and Selection of Fodder Crops.

A careful inquiry into the history of agriculture, down to the middle of the present century, has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed, with much propriety in the majority of instances, mainly to two causes, namely: a gradual but serious reduction in the area occupied by forage crops, natural pastures and meadows; and a marked decline in the annual yield of fodder upon large tracts of land but ill suited for a permanent cultivation of grasses, — the main reliance of fodder production at the time. A serious falling off in the annual yield of pastures and meadows was followed usually by a reduction in farm live stock, which in turn caused a falling off in the principal home resource of manurial matter. This chapter in the history of farm management has repeated itself in most countries. The unsatisfactory results of that system of farming find still an abundant illustration in the present exhausted condition of a comparatively large area of farm lands in New England.

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* See annual reports for 1889 (page 189) and 1890 (page 135); also Bulletin No. 36.

Scientific investigations carried on during the past fifty years for the particular benefit of agriculture have not only been instrumental in recognizing the principal causes of an almost universal periodical decline of the original fertility of farm lands, but have also materially assisted by field experiments and otherwise in introducing efficient remedies to arrest the noted decline in the annual yield of our most prominent farm crops. As a scanty supply of manurial matter, due to a serious falling off of one of the principal fodder crops (pastures and meadow growth), was found to be one of the chief causes of less remunerative crops, and thus indirectly has proved to be the main cause of an increase in the cost of the products of the animal industry of the farm, — milk and meat, — it is but natural that the remedies devised should include, as one of the foremost recommendations, a more liberal production of nutritious fodder crops. The soundness of this advice is to-day fully demonstrated in the most successful agricultural regions of the world. An intensive system of cultivation has replaced in those localities the extensive one of preceding periods; although the area under cultivation for the production of general farm crops has been reduced, the total value of the products of the farm has increased materially in consequence of a more liberal cultivation of reputed fodder crops. The change has been gradual and the results are highly satisfactory.

Viewing our own present condition, we notice that well-paying grass land, good natural meadow, with rich and extensive pastures, are rather an exception than the rule. The benefits derived from indifferently yielding natural pastures are more apparent than real; the low cost of the production of the fodder is frequently, in a large degree, set off by a mere chance distribution of the manure produced. A continued cultivation of one and the same crop upon the same land, without a liberal, rational system of manuring, has caused in many instances a one-sided exhaustion of the land under cultivation. This circumstance has frequently been brought about in a marked degree by a close rotation of mixed grasses (meadow growth) and of our next main reliance for fodder, — the corn (maize). Both crops require potash and phosphoric acid in similar proportion (four parts potassium oxide to one part phosphoric acid), and both require an exceptional amount of the former. There is good reason to assume that the low state of productiveness of many of our farms, so often complained of, is largely due to the fact that crops have been raised in succession for years, which, like those mentioned, have consumed one or the other essential article of plant food in an exceptionally large proportion, and thereby have gradually unfitted the soil for their remunerative production, while a liberal supply of other important articles of plant food is left inactive behind. As the amount of available plant food contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lay idle must reduce the interest on the investment.

Our personal observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, without any previous application of manure, an exceptionally large crop of horse beans and lupine, — two reputed fodder crops. A similar observation was made during the past season, when lands which for years had been used for the production of English hay and corn were used for the cultivation of southern cow-pea, serradella and a mixed crop of oats and vetch, to serve as green fodder for milch cows.

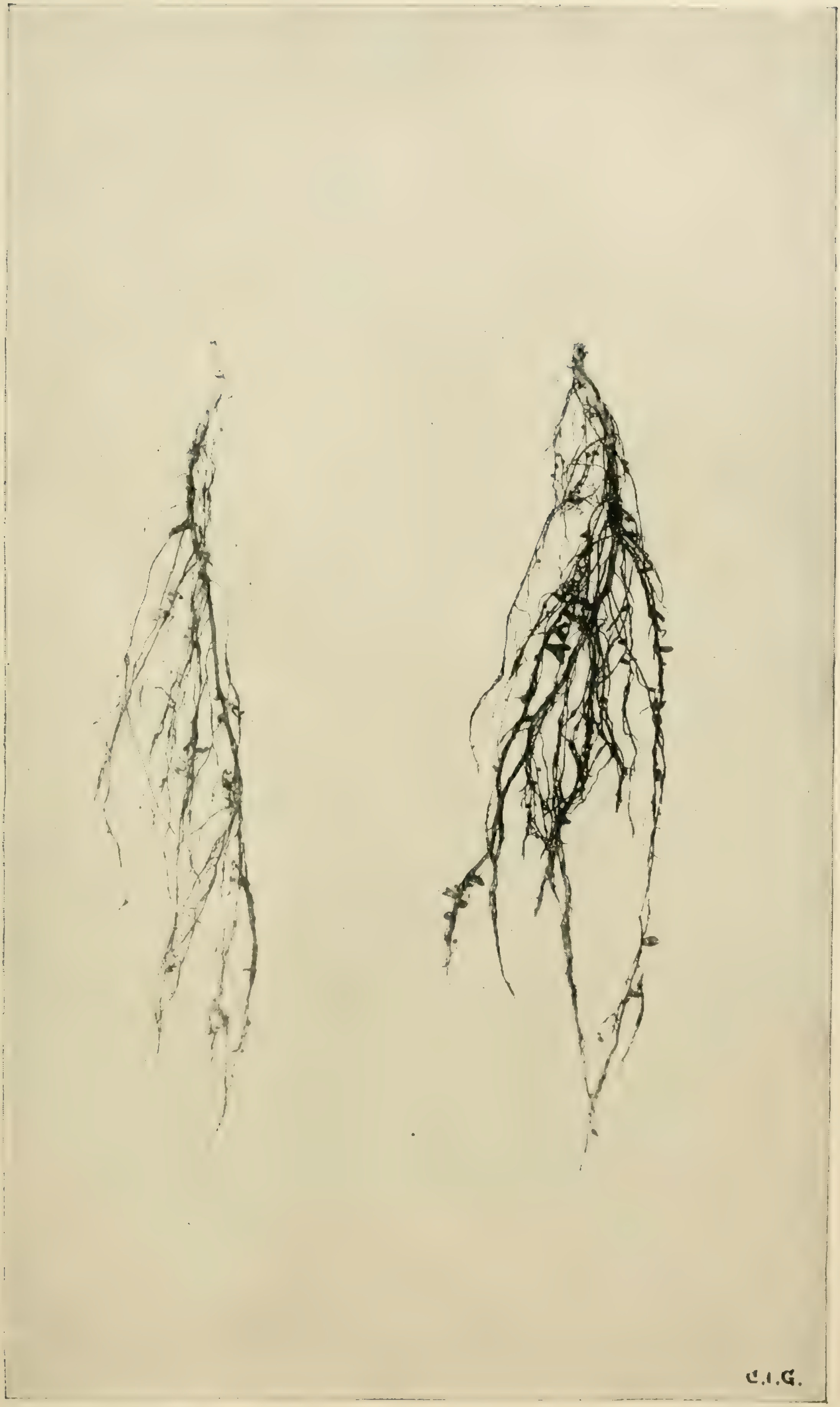
The field engaged for the production of these crops was not manured, because it was to be prepared for a special field experiment during the present season. An area of this land, which, under favorable circumstances, would not produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and oats, ten tons of green southern cow-pea and from twelve to thirteen tons of green serradella. The exceptional exhaustion of our lands in potash has been shown by detailed description of experiments with fodder corn in previous annual reports. (Field A, annual reports IV., V. and VI., 1886–88.)

The results obtained during past years tend to confirm the opinion held by successful agriculturists, that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with some hoed crop, to kill off the foul growth and to improve the physical and chemical condition of the soil. These lands prove in many instances ultimately a far better investment when used for the raising of other farm crops than grasses. The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhaustion of the soil, and the sooner, as a rule, will be noticed a decrease in the annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows), — the fodder corn and corn stover.

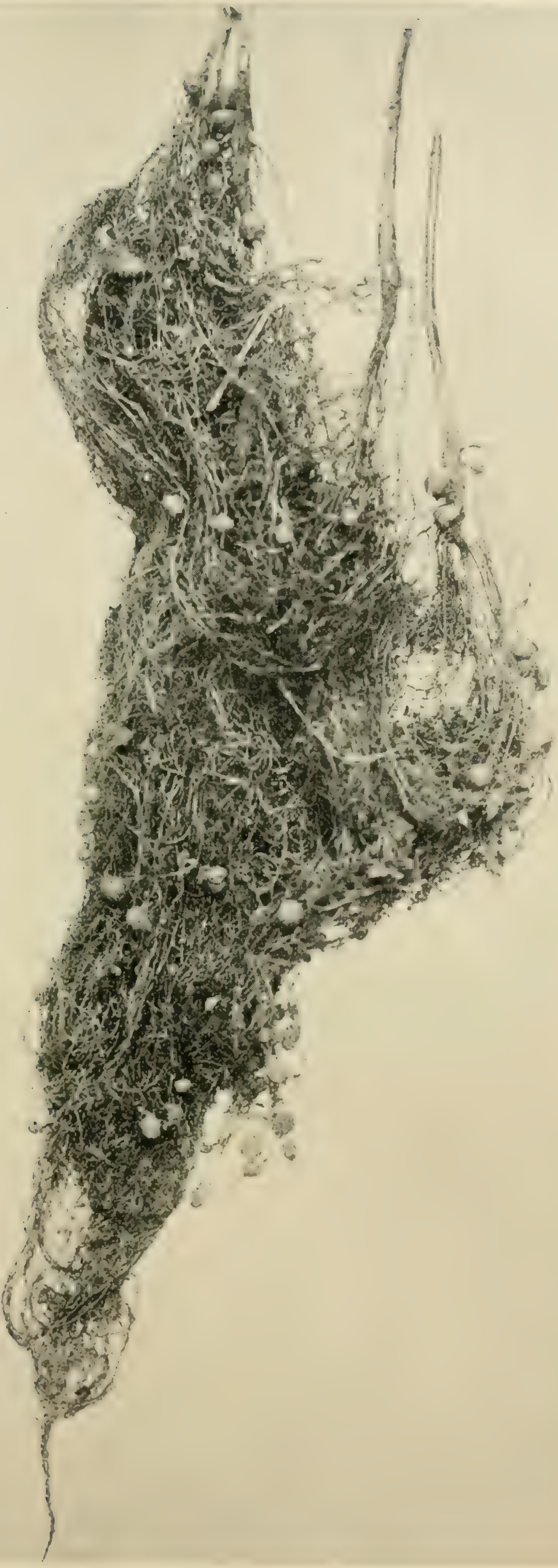
Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, peas, beans, lupines, etc., is, in a particular degree, well qualified for that purpose on account of its fitness to secure largely its nitrogen from the elementary nitrogen of the air by the aid of bacterial action. The photographs of the roots of several prominent leguminous forage plants, which accompany this chapter, show the swellings (tubercules) due to the bacterial action, — summer vetch, blue lupine, horse bean, serradella.

The following table may serve as an illustration of the relative economical value of various prominent fodder and forage crops.

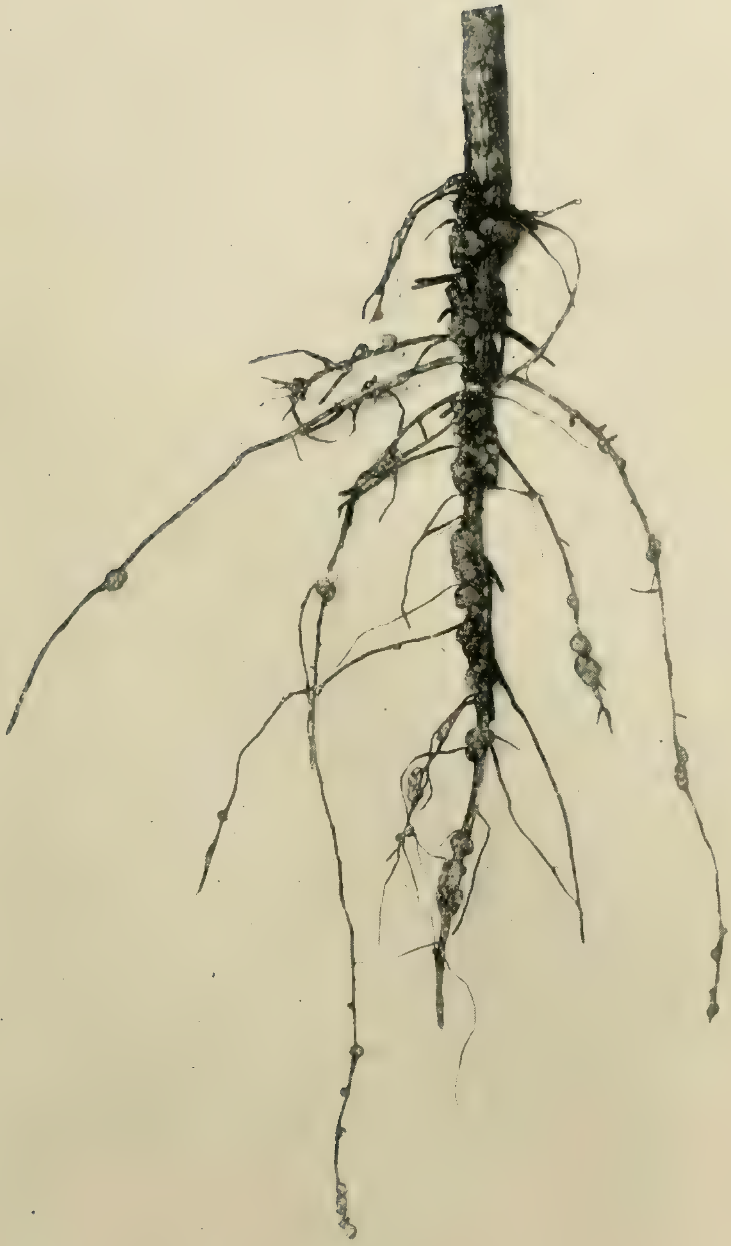
The manurial value of the various crops mentioned depends for obvious reasons on the temporary current prices of their fertilizing constituents in the general market of commercial fertilizers.



No. 1. Summer Vetch (*Vicia sativa*).

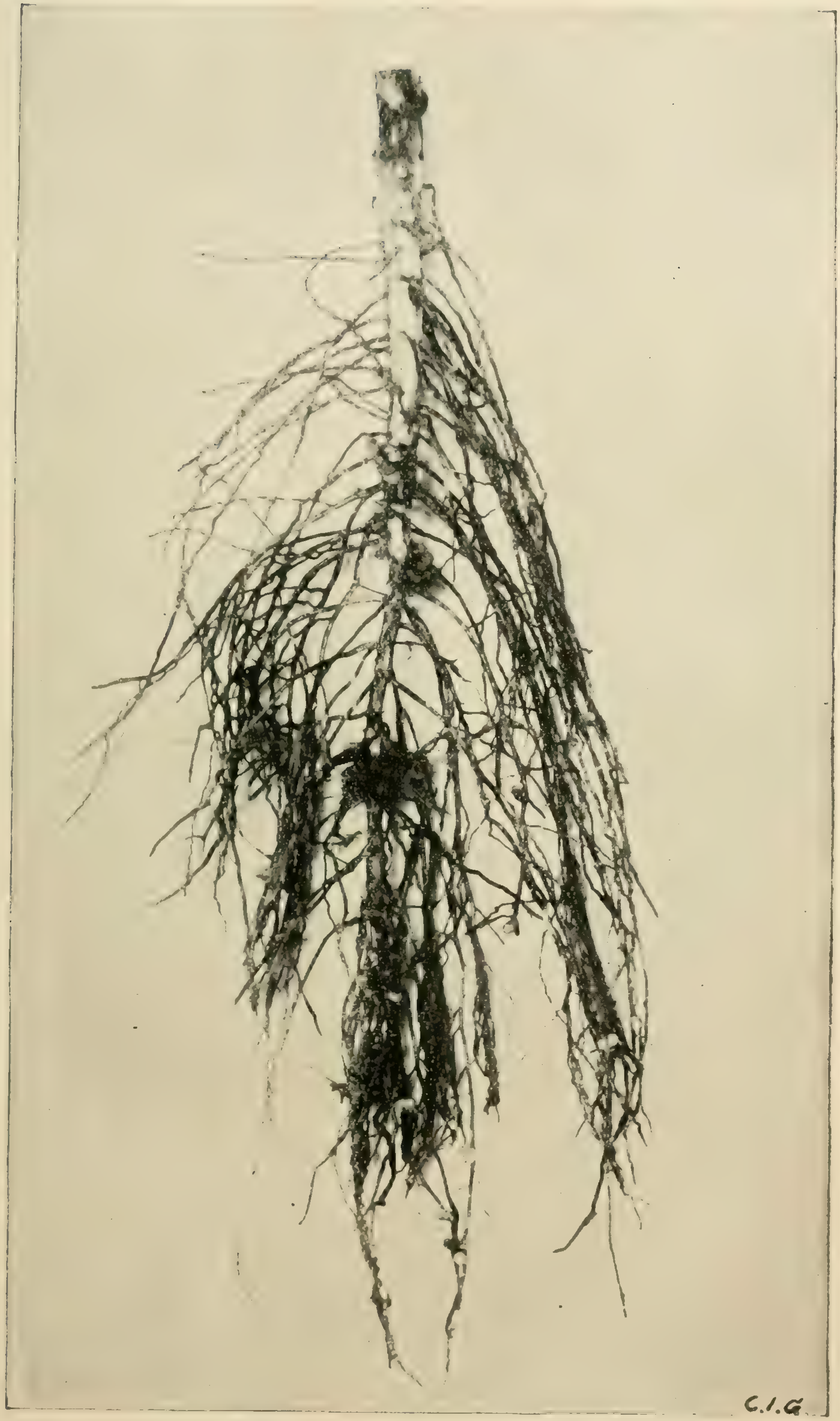


No. 2. Soja Bean (*Soja hispida*).



C.I.G.

No. 3. Blue Lupine (*Lupinus cæruleus*).



No. 4. Horse Bean (*Vicia Faba*).

Composition of Fodder Crops raised upon the Station Grounds.

NAME OF CROP. (SUITABLE FOR FEEDING.)	Nutritive Ratio.	FODDER CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.					FERTILIZING CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.			Manurial Value per Ton of Dry Matter.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	
Medium clover (*Trifolium pratense*),	1:2.5 to 1:5.5	89.0	299.7	26.2	146.3	438.8	23.40	4.88	24.65	$10 64
Alsike clover (*Trifolium hybridum*),		116.7	261.8	26.6	162.2	432.7	25.88	7.81	24.72	11 86
Cow-pea (*Dolichos*),		69.2	235.9	24.8	145.9	524.2	23.40	5.79	14.44	9 86
Serradella (*Ornithopus sativus*),		116.9	324.9	23.7	149.6	384.9	23.94	8.04	24.12	11 15
Vetch (*Vicia sativa*),		82.4	303.7	25.0	150.9	438.0	24.14	5.47	12.75	9 95
Soja bean (*Soja hispida*),		75.1	212.6	59.9	154.0	497.5	24.78	4.66	16.53	10 39
Lucerne (*Medicago sativa*),		81.1	297.2	16.5	142.2	463.0	22.75	5.61	15.59	9 73
Herds grass (*Phleum pratense*),	1:5.5 to 1:9.5	53.3	328.7	20.1	85.2	512.7	13.95	4.97	16.54	6 75
Corn stover,		50.3	320.2	16.5	79.2	533.8	12.67	4.22	18.39	6 38
Fodder corn,		48.8	314.0	15.3	72.1	549.8	11.54	7.38	10.99	5 75
Oats (entire plant),		60.8	343.2	26.9	108.9	460.2	17.42	7.81	22.90	8 81
Barley (entire plant),		49.5	291.2	27.6	102.6	529.1	16.42	6.44	19.53	8 02
Millet,		54.9	335.4	17.4	75.9	516.4	12.14	5.03	10.89	5 66
Hungarian grass (*Setaria italica*),		71.5	246.6	10.1	93.8	578.0	15.01	6.24	13.50	7 00
Japanese buckwheat,		123.6	360.2	22.2	108.0	386.0	17.28	9.04	35.21	9 95
Sugar beets,	1:9.5 to 1:13	46.4	60.0	6.5	108.4	778.7	17.34	5.41	18.57	8 12
Ruta-bagas,		97.5	118.3	15.3	110.1	658.8	17.62	10.76	41.05	10 77
Mangel-wurzels,		90.6	79.4	8.8	103.7	717.5	16.59	7.32	30.13	9 08
Carrots,		81.4	95.3	25.0	88.4	709.9	14.14	10.02	54.11	10 61

Scale, 4 rods to 1 inch.

5. TRIAL OF AN EARLY VARIETY OF MINNESOTA DENT CORN (HURON).

Field E.

The field is 260 feet long and 48 feet wide, containing 286 acres. The field was ploughed April 24 ; it was fertilized May 7, at the rate of 600 pounds of fine-ground bone and 300 pounds of muriate of potash per acre, applied broadcast and harrowed in. May 8 the corn (variety Huron) was planted, six quarts of seed being used for the plat. The corn appeared above ground May 19. The field was cultivated and hoed June 7 and 26. September 1 part of the corn was cut and stocked, while the remainder was fed out. Owing to the dry season, this trial with the corn was not a fair one, as the development of the crop was greatly retarded.

6. FIELD EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES TO STUDY THE ECONOMY OF USING THE CHEAPER NATURAL PHOSPHATES OR THE MORE COSTLY ACIDULATED PHOSPHATES.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever: —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Potatoes were raised upon the plats in 1890; in 1891 winter wheat was employed (for details see ninth annual report); in 1892 serradella was the crop experimented with (see tenth annual report); and in 1893 a variety of Dent corn, Pride of the North (see eleventh annual report).

1894. — During the preceding season it was decided to ascertain the after-effect of the phosphoric acid applied during previous years by excluding it from the fertilizer applied. In addition, to secure the full effect of the phosphoric acid stored up, the potassium oxide and nitrogen were increased one-half, as compared with preceding seasons. A grain crop (barley) calling for a liberal amount of phosphoric acid was chosen for the trial. The field was ploughed April 17, the fertilizer being applied broadcast April 25, and harrowed in. Below is given a statement of fertilizer applied: —

Plat 1 (6,494 square feet), ...	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet), ...	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet), ...	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet), ...	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet), ...	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

May 2 the barley was sown in drills two feet apart, at the rate of two bushels per acre. May 8 the barley was coming up on the plat. The field was kept free from weeds by cultivation.

Height of Plants.

[Inches.]

	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.
June 12, ...	14	13	10	14	14
June 18, ...	18	15	12	16	16
June 26, ...	28	26	21	24	27

June 26 the plants on plats 1, 2, 4 and 5 were beginning to show heads; No. 3 was somewhat behind the others. July 30 the barley was cut. The yield of barley from the different plats is given below: —

Yield of Crop (1894).

PLATS.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Summary of Yield of Crop (1890–94).

PLATS.	**1890.** Potatoes.	**1891.** Wheat.	**1892.** Serradella.	**1893.** Corn.	**1894.** Barley.
Plat 1, ...	1,600	380	4,070	1,660	490
Plat 2, ...	1,415	340	3,410	1,381	405
Plat 3, ...	1,500	215	2,750	1,347	290
Plat 4, ...	1,830	380	3,110	1,469	460
Plat 5, ...	2,120	405	2,920	1,322	390

Phosphoric Acid applied to and removed from Field.

[Pounds.]

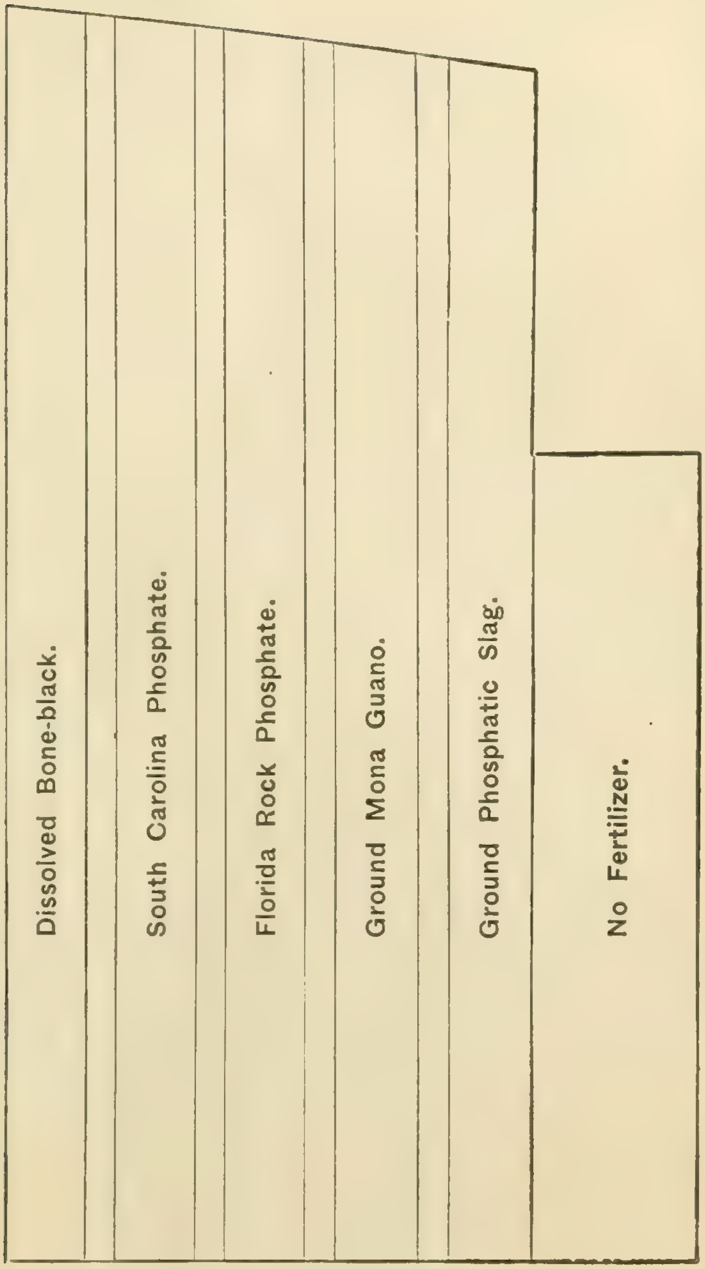
PLATS.	**1890.**		**1891.**		**1892.**		**1893.**		**1894.**		Total Amount Added.	Total Amount Removed.	Total Amount Remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	–*	1.92	96.72	21.86	75.86
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	–*	1.64	72.04	19.02	53.02
Plat 3, .	109.68	2.40	–*	.69	28.01	6.05	28.01	5.95	–*	.76	165.70	15.85	149.85
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	–*	1.72	144.48	19.84	124.64
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	–*	1.49	49.36	18.57	30.79

* None.

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the first two years, while for the third, fourth and fifth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

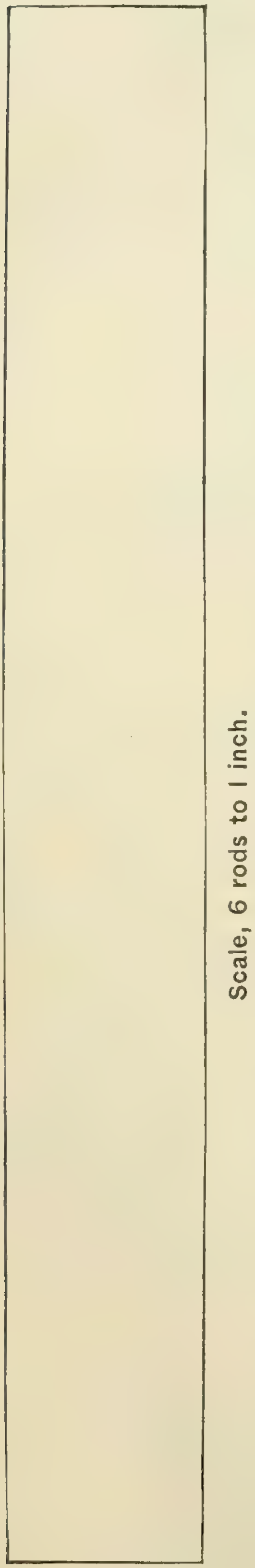
Field "F," 1894.


Dissolved Bone-black.
South Carolina Phosphate.
Florida Rock Phosphate.
Ground Mona Guano.
Ground Phosphatic Slag.
No Fertilizer.

Barley.

Scale, 4 rods to 1 inch.

7. EXPERIMENTS WITH FORAGE CROPS (VETCH AND OATS FOR FIRST CROP, HUNGARIAN GRASS FOR SECOND).


Field "G," 1894.

Field G.

The field is 700 feet long and 75 feet wide, and contains 52,500 square feet, or $1\frac{1}{5}$ acres. The field was ploughed Oct. 25, 1893. April 17 the artichokes were removed from the southern end of the field (see preceding annual report). It was fertilized with barnyard manure, applied at the rate of ten tons per acre. The field was again ploughed April 18. Vetch and oats was the crop selected for trial, being sown at the rate of forty-five pounds of vetch and four bushels of oats per acre. The field was seeded in two portions. The seed was sown on the northern portion April 20, coming up April 28. The southern portion of the field was seeded May 11, the plants appearing above ground May 19. The crop made a very satisfactory growth, and on June 23 the feeding of the green material from the northern portion began (the vetch being in bloom and the oats heading out), continuing until July 2, when that remaining was cut for hay. July 6 the cutting from the southern portion began, continuing until the 18th, when that remaining was cut for hay. Following is given a statement of the yield from the field :—

	Pounds.
Green material fed (19.12 per cent. dry matter), ...	6,875
Hay of vetch and oats (73.65 per cent. dry matter), ...	4,980

at the rate of 5,000–6,000 pounds of hay per acre.

Analysis of the material collected July 2 showed the following composition: —

	Per Cent.
Moisture at 100° C,	80.88
Dry matter,	19.12
	100.00

Analysis of Dry Matter.

Crude ash,	4.48
" fibre,	27.78
" fat,	2.62
" protein,	22.56
Nitrogen-free extract matter,	42.56
	100.00

July 21 the field was again ploughed and harrowed, and on the 23d was sown to Hungarian grass, which began to appear above ground July 28. Its growth was very materially affected by the dry weather. The crop was cut for feeding from September 25 to October 16, the total weight obtained being 4,456 pounds, having an average of 60 per cent. of dry matter.

Conclusions.

From the above figures it will be seen that the practice of introducing early-maturing mixed crops like vetch and oats in connection with valuable second crops like Hungarian, etc., deserves serious attention, on account of their superior fitness for dairy stock.

8. FIELD EXPERIMENTS TO STUDY THE EFFECT OF PHOSPHATIC SLAG AND NITRATE OF SODA AS COMPARED WITH GROUND BONE ON THE YIELD OF OATS AND CORN.

East Field.

The field used for this experiment is situated south of the orchard and of the centre roadway. The soil consists of a loam, and has been under careful cultivation for several years. Its management during previous years can be seen from preceding annual reports.

1894. — During that season the operations on the field were as follows. (See accompanying diagram.) One acre on the upper (eastern) side was fertilized with: —

PLAT I. { 600 pounds of fine-ground bone and
200 pounds of muriate of potash.

The remaining portion (1.8 acres) was fertilized at the rate of: —

PLAT II. { 800 pounds of odorless phosphate,
200 pounds of muriate of potash, and
200 pounds of nitrate of soda per acre.

This corresponds per acre to: —

	No. 1 (Bone).	No. 2 (Phosphate).
Potassium oxide,	104	104
Phosphoric acid,	131	166
Nitrogen,	24	31

Composition of Fertilizer Applied.

	PER CENT.		
	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Ground bone,	4.09	21.86	–
Odorless phosphate,	–	20.84	–
Muriate of potash,	–	–	52.20
Nitrate of soda,	15.79	–	–

Cost of Fertilizers.

	Per Acre
Ground bone and muriate of potash,	$12 40
Odorless phosphate, nitrate of soda and muriate of potash,	15 70

April 6 the odorless phosphate was applied to the lower portion of the field. The field was ploughed April 20–23. April 27 the remainder of the fertilizer was applied, and oats were sown on one acre set off at the north end of the field. May 5 the oats began to come up.

Height of Oats.

[Inches.]

June 5,	10
June 18,	19
June 26,	24

The oats began to head out June 25, and on July 25 they were cut, yielding as follows: —

Upper Part (Bone and Muriate), .35 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds),	760	2,171
Grain (pounds),	186	531

Lower Part (Odorless Phosphate, etc.), .65 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds),	2,120	3,261
Grain (pounds),	570	876

The remaining portion of the field was planted to corn (Pride of the North) on May 15; May 26 the corn was coming up. The field was cultivated and hoed June 8 and

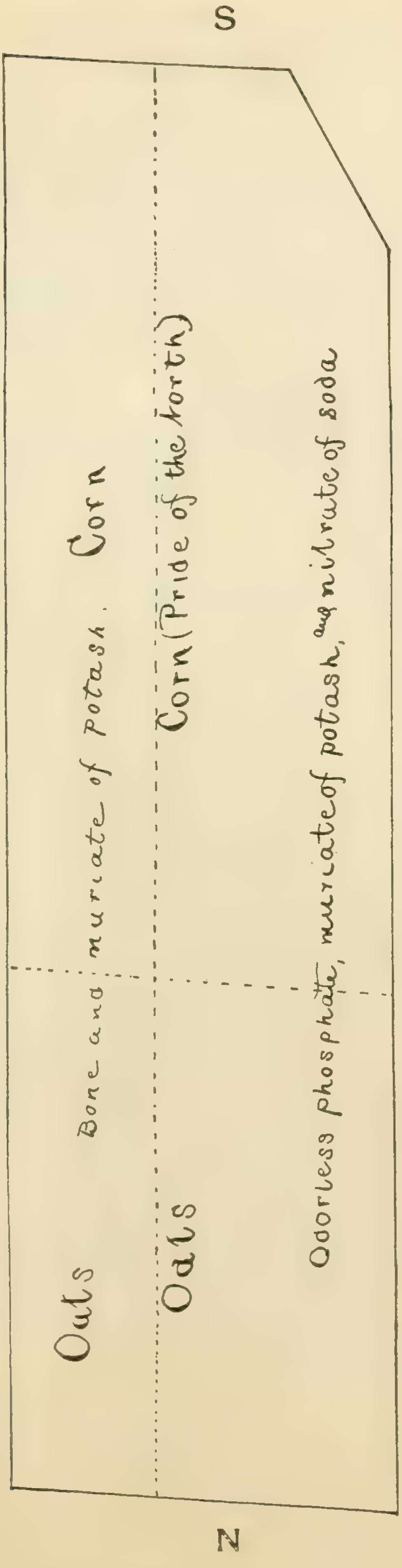
21 and July 2 and 11. August 29 the corn was cut for silage, yielding as follows: —

The upper part (bone and muriate), .7 acre, yielded 11,406 pounds, or 16,294 pounds per acre; the lower part (odorless phosphate, etc.), 1.2 acres, yielded 24,730 pounds, or 20,608 pounds per acre.

Summary of Yield (1894).

[Pounds.]

	Per Acre.	
	Plat 1 (Bone, etc.).	Plat 2 (Odorless Phosphate, etc.).
Oats (grain), ...	531	876
Oats (straw), ...	1,640	2,385
Corn, ...	16,294	20,608


S
Corn
Bone and muriate of potash.
Oats
Corn (Pride of the North)
Oats
Odorless phosphate, muriate of potash, and nitrate of soda
N

Scale, 100 feet to 1 inch.

9. EXPERIMENTS WITH PERMANENT GRASS LANDS (MEADOWS).

The meadows under consideration comprise an area of about 9.6 acres. The entire field up to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower portion. The improvement of the land by underdraining was commenced in 1886 and continued during the succeeding years. For details of the work see ninth and tenth annual reports (1891–92).

In the spring of 1893 a change was made in the *mode* of manuring of the grass plats. It was decided to study the effect of *a rotation of the three kinds of manures previously applied* upon the fields. The area was divided into three plats, Plat 1 (3.97 acres) being the area heretofore covered by plats 1 and 2; Plat 2 (2.59 acres) and Plat 3 (3 acres) correspond to plats 3 and 4 of previous years. The system of manuring adopted was as follows: —

Plat 1. — Wood ashes, 1 ton to the acre.
Plat 2. — Barn-yard manure, 8 tons per acre.
Plat 3. — Six hundred pounds fine-ground bone and 200 pounds muriate of potash per acre.

1894. — The above arrangement of plats was continued during the present season, and the fertilizers were applied in the same proportion to the same plats.

Yield of Hay (1894).

	PER PLAT.			PER ACRE.		
	Plat 1.	Plat 2.	Plat 3.	Plat 1.	Plat 2.	Plat 3.
First cut,	9.94	7.41	7.62	2.50	2.86	2.54
Second cut,	1.41	1.33	.56	.37	.51	.18
Total yield,	11.35	8.74	8.18	2.87	3.37	2.72

Yield of Hay (1889–94).

	Rate per Acre (Tons).		
	First Cut.	Second Cut.	Total
1889.			
Plat 1, barn-yard manure, 18 tons to acre,	2.73	1.14	3.87
Plat 2, barn-yard manure, 8 tons to acre,	2.38	1.21	3.59
Plat 3, 600 pounds steamed bone and 200 pounds muriate of potash,	2.50	1.03	3.56
1890.			
Plat 1, barn-yard manure, 14 tons to acre,	3.80	1.00	4.80
Plat 2, barn-yard manure, 11 tons to acre,	3.25	1.34	4.59
Plat 3, as in 1889 (bone and muriate of potash),	3.00	.73	3.73
Plat 4, wood ashes, 1 ton to acre,	2.23	.68	2.91
1891.			
Plat 1, barn-yard manure, 8 tons to acre,	3.26	.72	3.98
Plat 2, barn-yard manure, 6 tons to acre,	2.99	.72	3.71
Plat 3, as in 1890 (bone and muriate of potash),	2.32	.51	2.83
Plat 4, as in 1890 (wood ashes),	2.32	.51	2.83
1892.			
Plat 1, as in 1891 (barn-yard manure),	2.77	1.04	3.81
Plat 2, as in 1891 (barn-yard manure),	2.70	.98	3.68
Plat 3, as in 1891 (bone and muriate of potash),	2.33	.64	2.97
Plat 4, as in 1891 (wood ashes),	2.18	1.02	3.20
1893.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.28	.77	3.05
Plat 3, barn-yard manure, 8 tons to acre,	2.62	.86	3.48
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	1.94	.64	2.58
1894.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.50	.37	2.87
Plat 3, barn-yard manure, 8 tons to acre,	2.86	.51	3.37
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	2.54	.18	2.72

The past season was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent.

10. ORCHARD. EXPERIMENTS WITH HOME-MADE STABLE MANURE, UNLEACHED WOOD ASHES AND VARIOUS MIXTURES OF FERTILIZING MATERIALS ON THE GROWTH AND YIELD OF SEVERAL PROMINENT VARIETIES OF FRUIT TREES (APPLES, PEARS, PEACHES AND PLUMS).

The land used for the experiments described below is situated along the east side of the station farm. It borders on the west on a meadow, and on the eastern side is separated from a natural grove by a private road thirty-five to forty feet wide.

The soil consists of a somewhat sandy loam, with indications of light springs in various parts of the field. The more prominent springs have been connected by drain pipes with the main drain of the adjoining meadow since the experiment began.

The entire field slopes gently and quite uniformly from east to west. Corn and grasses represent in the main the crops raised upon the ground in years preceding 1887.

The inferior yield and character of the crops of later years raised upon the land pointed towards an indifferent management, as far as the selection of crops and of manure is concerned. To destroy weeds and other objectionable local growths, it became advisable to introduce a thorough system of drill cultivation, which was begun in 1888.

In 1889 a series of field experiments with different manures was instituted, which has been continued up to the present time. The system of manuring employed from 1888 to 1894 is given below: —

Fertilizer applied Each Year from 1889 to 1894.

Plat I. — Home-made mixed barn-yard manure, 18,000 pounds (rate of 10 tons per acre).

Plat II. — Wood ashes, 1,800 pounds (rate of 1 ton per acre).

Plat III. — No fertilizer.

Plat IV. — Ground bone, 540 pounds (rate of 600 pounds per acre); muriate of potash, 180 pounds (rate of 200 pounds per acre).

Plat V. — Ground bone, 540 pounds (rate of 600 pounds per acre); sulphate of potash and magnesia, 360 pounds (rate of 400 pounds per acre).

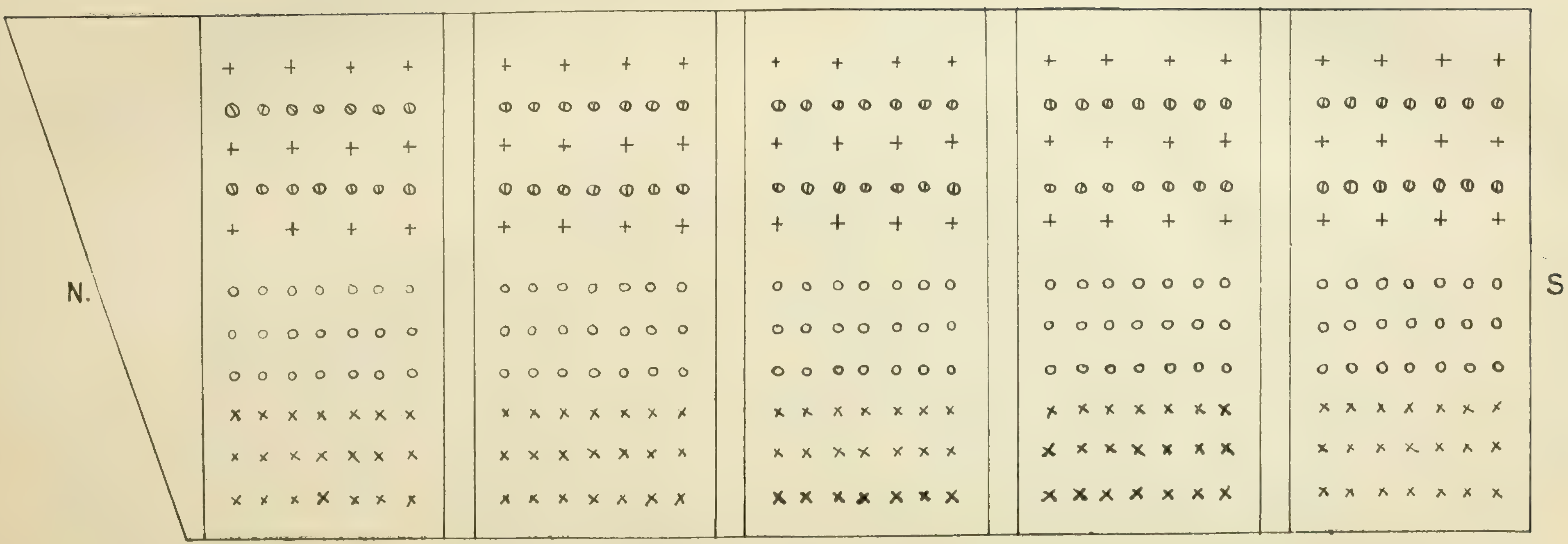
The details of the management of the field under discussion may be found in our annual report for 1893. In 1890 the main portion of the northern part was laid down as an orchard, a number of prominent varieties of apples, pears and peaches being set out in the order indicated in the accompanying diagram of the field. To these a number of varieties of plum trees was added in the fall of 1893. The system of cultivation was kept up as indicated in previous reports, barley and corn being raised (between the trees) in 1889; vetch and oats, Scotch tares and soja bean in 1890; barley and oats in 1891; Canada peas and oats, soja bean and Dent corn in 1892; vetch and oats, soja bean and barley in 1893; and in the fall of 1893 the orchard was seeded down to rye and grass. The space about four feet wide around the trees will be kept free from growth by means of the hoe, while the system of manuring as above will be continued for years to come, to ascertain the effect, if any, of the different systems of manuring on the growth and healthfulness of the stated varieties of trees under corresponding circumstances. The fertilizer will be applied as a top-dressing to each plat either in the spring or fall, as circumstances may advise.

Arrangement of Trees in Plats of Orchard.

Each plat contains the following varieties of trees, beginning at the south. The rows run east and west, and there are three trees in each row of apples, pears and peaches, and two in a row in case of plums: —

Apple.	Peach	Pear.	Plum.
Gravenstein,	Early Rivers,	Flemish Beauty,	German Prune.
	Beer's Smock,	Seckel,	German Prune.
Baldwin,	Coolidge Favorite,	Sheldon,	Green Gage.
	Early Crawford,	Bartlett,	Imperial Gage.
Roxbury Russet,	Old Mixon,	D'Anjou,	Jefferson.
	Stump of the World,	Lawrence,	Lombard.
Rhode Island Greening,	Late Crawford,	Buerre Bosc,	-

Orchard, 1894.



Scale 100 feet to 1 inch. + Apple. o Peach. × Pear. ⦶ Plum.

11. OBSERVATIONS IN THE VEGETATION HOUSE.

1. Observations with different forms of potash, phosphoric acid and nitrogen on garden crops (C. A. GOESSMANN).
2. Experiments with Philadelphia tankage and dried blood as a nitrogen source for the raising of winter grain (rye) (C. A. GOESSMANN).
3. Leather refuse, — its value in agriculture (J. B. LINDSEY).

From preceding descriptions of experiments carried on upon the fields of the station it will be noticed that our attention has been turned of late to a special study of the effect of different forms of nitrogen and potassium oxide on the growth of a series of prominent fruit and garden crops. The results of three years' observations regarding the latter are already reported in detail upon preceding pages (Field C).

To explain the striking differences noticed in the yields of some of those crops, in particular lettuce and tomatoes, when raised with the assistance of either muriate or sulphate of potash (upon Field C), it seemed advisable for confirmation of the results to transfer the investigations to the vegetation house, where, under better-defined circumstances, the special effects of the kind and form of the various articles of plant food supplied, as well as the most suitable quantity of each (nitrogen, potassium oxide and phosphoric acid), could be more clearly demonstrated. General observations with fertilizers in the vegetation house began four years ago.

1. OBSERVATIONS WITH DIFFERENT FORMS OF POTASH, PHOSPHORIC ACID AND NITROGEN ON GARDEN CROPS.

BY C. A. GOESSMANN.

The first systematic attempt in the above-stated direction was made during the winter of 1892–93. The soil used in the vegetation house during that year was a sandy loam taken a few feet below the surface from a locality which at no time had received an additional supply of manurial matter from an outside source. It was sent through a screen before being used, to remove coarse vegetable matter (roots, etc.). *Lettuce* and *New Zealand spinach* were used for the observation.

The relative proportion of fertilizer applied was: of potassium oxide, 3 parts; of phosphoric acid, 1 part; and of nitrogen, 1 part. The percentage of the different ingredients added to the soil was as follows: —

	Per Cent.
Potassium oxide,	.00026
Phosphoric acid,	.00009
Nitrogen,	.00009

The lettuce seeded in the boxes containing muriate of potash as the potash source proved a complete failure, as the young plants attained a height of only one and one-half inches, the color of the leaves changed into various shades of red, and growth ceased. In the other boxes the results were less striking, but the most satisfactory growth was obtained in those boxes in which sulphate of potash or sulphate of potash-magnesia furnished the source of potash.

Less marked was the difference in growth of the New Zealand spinach, the plants growing in the boxes containing muriate of potash being at first less vigorous; the difference in the yield at the close of the experiment was not so marked, except in regard to the time required to reach perfection. The most striking fact noticed with regard to these preliminary experiments was the apparently injurious effect of muriate of potash on lettuce. This result induced me to repeat the experiment in the vegetation house during the winter of 1893–94 (see annual report).

The soil turned to account during that season was obtained two feet below the surface of an abandoned pasture, which had not received any addition of manurial matter from an outside source for many years. The soil was screened, thus being freed from coarse material of every description. It consisted of a light loam. Twelve boxes (marked from 1 to 12), corresponding in size to those of the previous year (32 by 32 by 8 inches), were employed, each containing about three hundred pounds of the soil, being filled to within one inch of the top. To secure a thorough mixing of the fertilizer and soil, they were worked together with the shovel and the mixture sent twice through the screen. The addition of the fertilizer to the soil was made two weeks in advance of the seeding. A greater variety of fertilizer mixtures was turned to account, including those of the preceding year. The potassium oxide was furnished by muriate of potash (1, 2 and 3), sulphate of potash (4, 5, 6 and 12), carbonate of potash-magnesia (7, 8, 9 and 10) and phosphate of potash (11). The phosphoric acid was supplied by dissolved boneblack (1, 2, 3, 4, 5, 7, 8 and 9), odorless phosphate (6), double superphosphate (10), phosphate of potash (11) and phosphate of ammonia (12). The nitrogen was added in the form of nitrate of soda (1, 4, 7, 10 and 11), sulphate of ammonia (2, 5 and 8), phosphate of ammonia (12) and organic nitrogen (dried blood) (3, 6 and 9). The relative ratio of essential fertilizing constituents applied was four parts potassium oxide, one part phosphoric acid and one part nitrogen. The percentage of the essential elements of plant food applied to the soil in boxes 1–9 (inclusive) was as follows: —

	Per Cent.
Potassium oxide,	.0004
Phosphoric acid,	.0001
Nitrogen,	.0001

The proportions for the remaining boxes are given below: —

	Per Cent.		
	Box 10.	Box 11.	Box 12.
Potassium oxide,	.0004	.0004	.0004
Phosphoric acid,	.0004	.0004	.0004
Nitrogen,	.0001	.0002	.0001

Following is a statement of the fertilizer mixtures used: —

Box 1.

128 grams muriate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 2.

128 grams muriate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 3.

128 grams muriate of potash.
100 grams dissolved bone-black.
155 grams dried blood.

Box 4.

128 grams sulphate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 5.

128 grams sulphate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 6.

128 grams sulphate of potash.
90 grams odorless phosphate.
155 grams dried blood.

Box 7.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 8.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 9.

360 grams carbonate of potash-magnesia.
100 grams dissolved bone-black.
155 grams dried blood.

Box 10.

136 grams double superphosphate.
360 grams carbonate of potash-magnesia.
106 grams nitrate of soda.

Box 11.

200 grams phosphate of potash.
212 grams nitrate of soda.

Box 12.

145 grams phosphate of ammonia.
128 grams sulphate of potash.

Analyses of chemicals used in compounding the above mixtures will be found below: —

	Potassium Oxide.	Phosphoric Acid.	Nitrogen.
	Per Cent.	Per Cent.	Per Cent.
Muriate of potash,	46.00	–	–
Sulphate of potash,	50.20	–	–
Potash-magnesia sulphate,	24.32	–	–
Carbonate of potash-magnesia,	18.48	–	–
Phosphate of potash,	32.56	35.70	–
Dissolved bone-black,	–	13.88	–
Odorless phosphate,	–	18.42	–
Double superphosphate,	–	47.80	–
Phosphate of ammonia,	–	43.86	10.37
Dried blood,	–	4.02	10.00
Nitrate of soda,	–	–	14.28
Sulphate of ammonia,	–	–	19.59

A greater variety of garden vegetables was selected for trial. Each box was planted on October 11 with seed of the following: —

Lettuce, variety Hanson.
Spinach, variety New Zealand.
Beets, variety Egyptian.
Tomato, variety Essex Hybrid.

The boxes were treated similarly with regard to temperature and time of watering. To control the experiment, part of the vegetation house was turned to account to raise the same varieties of vegetables in the same soil, properly manured with vegetable compost from a successfully managed hot-bed. On October 17 the lettuce and spinach appeared, and by October 20 the remaining seeds had sprouted. The following notes relating to the different garden vegetables on trial may not be without interest in this connection, although still of a preliminary character: —

Lettuce. — The seed germinated well in all cases except with box 12, in which the number was somewhat scanty. During the first two or three weeks of growth the difference in the boxes was not very marked, although on November 20 1, 2 and 3 were noted as being generally of poorer quality than the others, with 4, 5 and 6 next. Nos. 2 and 5 were the poorest in their respective groups in which the nitrogen was furnished by ammonia salts. In boxes 8 and 12 the same failure was noticed.

The lettuce was removed from 9 and 10 January 10, having made a very satisfactory growth, and on January 20 from 7 and 8, also with a good growth.

Beets. — The seed germinated well in all cases, and during the first part of the growing period no very great differences were observed in the general appearance of the various boxes. The plants in 7, 8, 9, 10 and 11 proved the most satisfactory, being removed January 31.

Spinach. — This crop grew better in proportion in all the boxes than either of the others on trial. In 1, 2 and 3 it made a fair growth, although not as vigorous as in the remaining boxes; 4, 5 and 6 showed a more vigorous and rapid growth, while 7, 8 and 9 proved to be still more vigorous. Boxes 10 and 11 showed a corresponding relative increase in growth, the plants being removed on January 3, when in bloom.

Tomatoes. — The growth of the tomatoes in 1, 2 and 3 was less satisfactory than in most of the others. The degree of growth under the influence of different fertilizers may be noticed from the following table, expressing the heights of the plants at different periods of the observation: —

Height of Tomato Plants.

[Inches.]

DATE.	BOXES.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
December 5, . . .	5½	2¾	3	8	5	5	6½	8½	8	13½	9	8½
December 19, . . .	9½	6½	7	18	10	11½	11	14	14	24	21	21
January 9, . . .	26	10	25	36	22	22	28	31	32	45	44	43

The plants came in bloom as follows: in box 10, on December 18; in box 11, on December 20; in box 12, on December 23; in boxes 4, 5, 6, 7, 8 and 9, on January 1; and in boxes 1 and 3, on January 3. The plants in box 2 came in bloom February 15.

Fruit was formed first on the plants in box 10, noticed on January 17. It first appeared in box 12 on January 18; in boxes 4 and 9 on January 21; in box 3 on January 24; in box 1 on January 27; in box 8 on February 5; and in box 7 on February 28.

Fruit ripened in box 10 on February 20; in boxes 3, 4 and 12, on February 28; in box 9, on March 1; and in box 8, on March 7.

The plants grown in the soil manured with vegetable compost, as a sort of control experiment, made a very vigorous and healthy growth, but blossomed late and had formed no fruit up to March 8, although retaining their promising appearance.

Conclusions.

Lettuce did best in boxes 10, 9, 7 and 8; beets did best in boxes, 7, 10, 8, 4 and 11; spinach did best in boxes 10, 11, 7, 8 and 9; tomatoes did best in boxes 10, 12, 4 and 9.

1894–95. — During the past summer the boxes of the vegetation house were removed and replaced by others somewhat larger. The arrangement for sub-irrigation previously used in box 4 gave such good satisfaction that all of the boxes were similarly equipped.

The soil used for filling the boxes was obtained about six inches below the surface of land which had not been under cultivation for a considerable period. This soil was carefully screened, to remove coarse particles. Each box received about seven hundred and fifty pounds of the earth, to which the fertilizer had been applied and carefully mixed before filling in. The proportion of essential fertilizing ingredients applied to the soil is as follows: —

Boxes 1, 2, 3, 4, 5, 6, 7 and 8.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0014
Nitrogen,	.0014

Boxes 9, 10, 11, 12, 14 and 15.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0056
Nitrogen,	.0014

Below is given a statement of the various fertilizer mixtures employed, the amounts stated being for one thousand pounds of soil: —

Box 1.

512 grams muriate of potash.

424 grams dissolved bone-black.

620 grams dried blood.

Box 2.

512 grams muriate of potash.

424 grams odorless phosphate.

620 grams dried blood.

Box 3.

512 grams sulphate of potash.

424 grams bone-black.

620 grams dried blood.

Box 4.

512 grams sulphate of potash.

424 grams odorless phosphate.

620 grams dried blood.

Box 5.

1,440 grams potash-magnesia carbonate.

136 grams double superphosphate.

620 grams dried blood.

Box 6.

1,440 grams potash-magnesia carbonate.

424 grams odorless phosphate.

620 grams dried blood.

Box 7.

512 grams sulphate of potash.

136 grams double superphosphate.

424 grams nitrate of soda.

Box 8.

1,440 grams potash-magnesia carbonate.

136 grams double superphosphate.

424 grams nitrate of soda.

Box 9.

544 grams double superphosphate.

1,440 grams potash-magnesia carbonate.

424 grams nitrate of soda.

Box 10.

580 grams phosphate of ammonia.

512 grams sulphate of potash.

Box 11.

800 grams phosphate of potash.

312 grams sulphate of ammonia.

Box 12.

544 grams double superphosphate.

312 grams sulphate of ammonia.

512 grams muriate of potash.

Box 13.

100 pounds compost.

Box 14.

580 grams phosphate of ammonia.
512 grams sulphate of potash.

Box 15.

800 grams phosphate of potash.
312 grams sulphate of ammonia.

Box 16.

100 pounds compost.

The analyses of the chemicals used in compounding the above mixture are given on a preceding page. The analyses of the soil used in filling the boxes, and of the compost applied (13 and 16), will be found below: —

	Soil.	Compost.
Moisture at 100° C.,	7.610	25.750
Phosphoric acid,	.195	.432
Potassium oxide,	.233	.375
Nitrogen,	.065	.458
Organic and volatile matter,	11.380	41.570
Insoluble matter,	85.800	55.150

The boxes were planted October 11 and 12 with the following varieties of vegetables: —

Tomato (the Lorillard).
Turnip (Early American Red Top).
Lettuce (Rawson's New Hot-house).

February 1, tomatoes are looking best in boxes 9, 10, 11 and 8, in the order named; fruit has set on 9 and 10, also on 3 and 4, although the plants have not made a very stocky growth. Turnips are developed most in boxes 13, 16, 14, 15 and 11, in the order named; 9, 10, 2, 3, 4 and 7 have made considerable leaf growth, but have not much root development.

Following is given a summary of results to April 1, 1895. The detailed statement must of necessity be left for future presentation.

Turnips.

[Harvested Feb. 21, 1895.]

	Number of Roots.	Average Diameter of Roots.	Total Weight of Roots.	Total Weight of Leaves.	Average Length of Leaves.
Box 1,	4	2.7	14.00	48.00	17.25
Box 2,	4	2.6	16.00	37.00	14.50
Box 3,	5	2.5	18.00	44.00	14.60
Box 4,	5	2.5	20.00	46.00	15.80
Box 5,	–	–	–	–	–
Box 6,	–	–	–	–	–
Box 7,	4	2.7	17.50	48.00	15.00
Box 8,	–	–	–	–	–
Box 9,	5	1.7	7.00	33.00	13.40
Box 10,	4	2.1	8.50	29.00	15.50
Box 11,	4	2.9	26.00	42.00	17.00
Box 12,	3	2.0	7.50	31.00	14.00
Box 13,	4	4.3	60.50	25.50	15.75
Box 14,	4	4.3	57.00	50.00	17.25
Box 15,	7	3.8	48.00	64.00	16.25
Box 16,	4	4.0	45.00	21.00	14.75

Roots in boxes 5, 6 and 8 have not been harvested.

Tomatoes.

[Summary of observations to April 1, 1895.]

	In Bloom.	Fruit Set.	Ripe.
Box 1,	March 25.	–	–
Box 2,	March 20.	April 2.	–
Box 3,	Jan. 6.	Jan. 22.	–
Box 4,	Jan. 8.	March 5.	–
Box 5,	April 2.	–	–
Box 6,	April 2.	–	–
Box 7,	Feb. 7.	April 1.	–
Box 8,	Jan. 15.	March 1.	–
Box 9,	Jan. 7.	Jan. 20.	March 15.
Box 10,	Jan. 1.	Jan. 20.	March 10.
Box 11,	Jan. 4.	Feb. 1.	March 26.
Box 12,	Jan. 20.	March 5.	March 12.
Box 13,	Jan. 4.	March 1.	–
Box 14,	Jan. 10.	March 1.	–
Box 15,	Jan. 5.	March 20.	–
Box 16,	Jan. 8.	March 1.	–

2. EXPERIMENTS WITH PHILADELPHIA TANKAGE AND DRIED BLOOD AS A NITROGEN SOURCE FOR THE RAISING OF WINTER GRAIN (RYE).

BY C. A. GOESSMANN.

1893–94. — The experiments described below were carried on for the purpose of comparing the value of dried blood and Philadelphia tankage as a nitrogen source for the raising of winter rye. The soil used in the experiment was obtained from a locality not under cultivation, and was carefully screened before use. Six boxes were filled, each with about seventy-five pounds of the earth.

Boxes 1 and 4 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Dried blood,	100

Boxes 2 and 3 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Philadelphia tankage,	100

The other two boxes received no fertilizer addition.

Sept. 21, 1893, winter rye was sown in the boxes. This began to appear above ground September 25, and October 12 the plants were thinned to five in a row, three rows in a box. During the winter the boxes were kept in the unheated portion of the vegetation house, and, to get as nearly as possible the outside conditions, snow was placed on the boxes at intervals, its melting furnishing the only water the boxes received during the winter. At the opening of spring the boxes were again regularly watered, during the summer receiving about four hundred cubic centimeters of water daily. No very striking differences were noticed in the appearance of the fertilized boxes, the average height being about thirty-six inches. The boxes receiving no fertilizer averaged thirty inches in height. The plants were in bloom May 25. They were harvested July 27. They were kept until October 9, when the following weights were taken: —

Weight (Grams).

	TANKAGE.		BLOOD.		NOTHING.	
BOXES,	2.	3.	1.	4.	5.	6.
Number of heads,	41	41	51	41	25	18
Total weight,	10.67	13.10	12.50	9.07	8.25	5.02
Number containing grain,	24	32	26	23	21	13
Number empty heads,	17	9	25	18	4	5
Weight of straw,	22.17	22.57	33.45	22.80	16.70	11.60

1894–95. — The experiments with winter crops were continued during the winter of 1894–95, as follows: —

Ten boxes were filled with the same kind of earth used in the beds of the hot-house, about 100 pounds being used per box, together with the following fertilizer mixtures: —

Box 1.

7.68 grams sulphate of potash.
24.38 grams bone-black.
24.38 grams nitrate of soda.

Box 2.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
24.38 grams nitrate of soda.

Box 3.

7.68 grams sulphate of potash.
24.38 grams bone-black.
18.72 grams sulphate of ammonia.

Box 4.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
18.72 grams sulphate of ammonia.

Box 5.

7.68 grams sulphate of potash.
24.38 grams bone-black.
40.22 grams dried blood.

Box 6.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
40.22 grams dried blood.

Box 7.

7.68 grams sulphate of potash.
24.38 grams bone-black.
51.16 grams Philadelphia tankage.

Box 8.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
51.16 grams Philadelphia tankage.

Box 9.

7.68 grams sulphate of potash.
24.38 grams bone-black.
56.64 grams leather refuse.

Box 10.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate
56.64 grams leather refuse.

The chemical composition of the above fertilizing ingredients can be ascertained from the table on page 277. The Philadelphia tankage contained seven and one-half per cent. nitrogen.

October 2, crops were planted in the boxes as follows: —

Boxes 1 and 2, winter rape.
Boxes 3 and 4, winter vetch.
Boxes 5, 6, 7, 8, 9 and 10, winter rye.

The seed germinated well and the plants made a good growth before winter, being left in the cold house and covered with snow during the winter season, to imitate as nearly as possible the outside conditions.

3. LEATHER REFUSE, — ITS VALUE IN AGRICULTURE.*

BY J. B. LINDSEY.

During the past few years claims have been made at various times that large quantities of leather shavings and the like have found their way into the so-called commercial fertilizers that are so widely used by the farmers of the United States. The writer has no means of knowing whether this claim is true or not. It should be the object of the fertilizer manufacturer to utilize all kinds of waste products that possess distinct manurial value. By so doing he not only benefits himself, but the farmer as well.

It was very early assumed from its chemical character, without any exact experiments upon which to base the assumption, that leather refuse would yield its nitrogen as plant food very slowly, if at all.

I. Historical Review.

1. Methods employed to make the Nitrogen available to Growing Plants.

The first method suggested, so far as the writer has been able to ascertain, was that prescribed by F. O. Ward † of England, in 1857, for turning to account woollen rags, wool, silk and leather clippings. The process as described was as follows: the refuse was introduced into an ordinary autoclave digester, and there kept for about three hours, surrounded by steam heated to a pressure of from three to five atmospheres. Wool required a higher temperature than leather, and silk than wool. The materials condensed a portion of the steam and absorbed its heat. This joint action converted the animal matter into a friable substance, which, however, still retained its original form and aspect. It was then ground fine, sifted and bagged. "The details of the process, the fuel and labor-saving arrangements that have been learned, point by point, by costly manufacturing experience, cannot," says Ward, "with propriety be divulged." The final product is described as a dark-colored powder. The nitrogen in the finished product is said to exist to a small extent as ready formed ammonia, being in combination with ulmic and humic acids developed during the process. It was stated at the time that this manufacturing process was carried on at large works on the Thames. The material for the most part was sold to manure manufacturers, who used it as an ingredient of their several fertilizing compounds, and it was "used by many farmers who are not aware of the fact." Ward says that, "while this material is not as active as some other forms of organic nitrogen, it possessed distinct value as a fertilizer."*

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* A portion of this article has already appeared in Agricultural Science, Vol. 8, Nos. 2 and 3, 1894.

† Report by the Juries of the International Exhibition, 1862. Reporter, A. W. Hoffman. Repertory of Patent Inventions, August, 1857, page 137.

Edw. Toynbee,† in 1858, also described a process whereby leather and wool waste could be cooked in sulphuric acid, and be made more available as a fertilizer. He said that "to one centner of sulphuric acid four or five centners of wool or leather waste could be added." The writer does not see how such a large amount of leather could be added to the acid, as will be shown further on. L. Meyer ‡ speaks of dissolving all such refuse substances in warm sulphuric acid, and neutralizing the moist mass with bone.

A. Lipowitz § notes the fact that the Posner fertilizer factory utilizes all such kinds of waste as have already been referred to.

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* The writer does not know whether this process is still in operation in England for utilizing the leather, wool and silk wastes.

† Repertory of Patent Inventions, 1858, page 389. Jahresbericht Agric. Chem., 1859.

‡ Jahresbericht Agric. Chem., 1859, 228.

§ Allgem. Zeitung für deutsche Land. und Forstwirthe, 1859, 153.

Runge * speaks of rendering leather and wool more available by dissolving them in a mixture of Glauber's salt and quick-lime. This chemist manufactured a fertilizer upon a large scale from these materials.

Reichardt † describes his method of subjecting the leather refuse to steam pressure, and then drying it quickly. After such a treatment he found 15.75 per cent. of the material to be soluble in boiling water, and that, after standing for some time, 20 per cent. could be dissolved. By treating the dry leather that had been subjected to steam with 20 to 40 per cent. sulphuric acid, he was enabled to dissolve from 22 to 29 per cent. of the leather in water. With a five per cent. solution of crystallized soda, 28.8 per cent. could be brought into solution. He therefore concluded that the best method was to subject the leather to the action of a weak soda solution.

Coignet's ‡ method was reported in 1874 by H. Mangon. Briefly stated, it is as follows: the refuse material is placed in a room having a cubic area of 20 meters. Directly outside of the room is a coke oven, connected with a chimney that has an opening into the room containing the material to be treated. Into this chimney are conducted jets of steam, so that the room is heated from 150° to 160° C. for several hours by this moist chimney air. Under these conditions the leather swells somewhat, and becomes dark, brittle, and can easily be rubbed to a powder.

Storer § says: "It is evidently with reference to this process that the statement has recently been made that certain manufacturers of fertilizers at Paris devote themselves particularly to the preparation of torrefied wool, horn, leather and even bone, the leather having first been steamed strongly to remove oil and gelatine."

L'Hote ‖ describes a method whereby such waste material

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* Jahresbericht Agric. Chem., 1865.

† Zeitschrift für deutsche Landwirtschaft, 1865, 136. Jahresbericht Agric. Chem., 1865.

‡ Organ der Vereinf. Rübenz. Industrie in Œster-Ungarn, 1874, 32. Jahresbericht Agric. Chem., 1873–1874, 37.

§ *Agriculture* I., 382.

‖ Centralblatt für Agric. Chem., **5**, 258. Illustrirte Landw. Zeitung, 1874, No. 2, 18.

as wool, leather, etc., can be converted into sulphate of ammonia. He suggests dissolving the material in a ten per cent. solution of caustic soda in the cold. The substances will be partly dissolved, or their structure more or less destroyed. The jelly-like mass is then mixed with caustic lime till it becomes of a doughy consistency. It is then brought into iron retorts, and heated at first at as low a temperature as possible, in order to prevent the dissociation of the ammonia, which is caught in sulphuric acid. After the gas has been nearly driven off, the retorts are subjected to red heat. At the end of the operation a white powdery substance is left behind, consisting of carbonate of soda and caustic lime. By cooking this substance with water, caustic soda is formed and can be again utilized. By this method all the nitrogen is obtained. The resulting sulphate of ammonia is somewhat colored.

For utilizing leather Rümpler * suggests the following method: in lead or iron jacketed kettles, sulphuric acid of 50° B. is heated very hot, and leather stirred in till a dark-brown fluid is obtained. This fluid is then used to dissolve the phosphate of lime. He remarks that "the nitrogen is saved, and without doubt is much more available from the fact that the tannin is destroyed."

Erhardt † suggests that such refuse material be slowly burned in closed ovens, and the gas collected in moist muck till the latter becomes saturated. This muck mixed with superphosphate gave, he says, a quick-acting manure.

Deherain ‡ says that this leather refuse can be dissolved in sulphuric acid, and the excess of acid neutralized with phosphate of lime. In this way he claims a very active fertilizer can be obtained at a low cost.

The writer understands that this latter method has been in quite general use for many years by European manufacturers. Not only has leather been thus treated, but also a great variety of nitrogen-containing refuse materials. American manufacturers also subject various waste materials to the action of sulphuric acid, in order to render them more quickly available.

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* Kaüfliche Düngestoffe. H. Rümpler, 1875 (Thaer Bibliothek).

† Jahresbericht Agric. Chem., 1880, 337.

‡ Deherain, *Chimie Agricole* [1892], 624.

From the many methods suggested for the utilization of leather waste, it is evident that in the older countries, specially England, France and Germany, this material, after having been submitted to some mode of treatment, is quite generally used, to a greater or less degree, in the manufacture of commercial fertilizers.

Petermann * says that "it is well known that certain Belgian and French manufacturers use leather in their products, but that such goods contain, in addition, nitrogen in other forms, such as blood, horn, meal, sulphate of ammonia and nitrate of soda." He further states that the "factories producing this material are numerous, and a considerable quantity is produced annually."

2. *Manurial Value of Prepared Leather Waste.*

The different experiments made to prove the value of leather have been conducted either with untreated finely ground leather, with torrefied leather, or with leather steamed under pressure.

Three different methods have been used in testing the agricultural value of leather: (*a*) by directly testing its fertilizing effect either in pot or plat experiments; (*b*) by artificially digesting it with a pepsin solution; (*c*) by noting the length of time required to nitrify it. The first method is by far the most interesting, and leads to direct results. The other two serve at least to confirm the results obtained by the first method.

A. Pot and Plat Experiments.

Very early experiments are not to be found in literature.

The first experiment recorded was made by Ladureau,† and lasted but a single season. He found that 2,500 kilos. of torrefied leather yielded 30,100 kilos. of sugar beets, testing 8.83 per cent. of sugar; and 2,500 kilos. of the same leather plus 200 hectolitres of lime gave 38,600 kilos. of beets, with 10.10 per cent. sugar. The same area of land without leather yielded 20,000 kilos. of sugar beets, testing

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* *Recherches de Chimie et Physiologie* [1885], 144.

† Annales Agron., 1878; *Loc. cit.*, 146.

10.93 per cent. sugar. Petermann remarks on these results as follows: "In spite of the increased yield obtained by using the leather, the experiment was not a success financially, and, further, the beets produced with the aid of the leather were poorer in quality than those without it."

In 1880 Petermann * carried out a series of experiments with ground steamed leather, to test its manurial value. It was very dry and brittle, and contained 7.51 per cent. of nitrogen and 0.81 per cent. of phosphoric anhydride soluble in hydrochloric acid.

The experiments were carried on in the plant house in pots, with oats; in the garden, with the horse bean (*Vicia faba*); and in the field, with sugar beets.

Experiments with Oats in Pots.

Each test was made in duplicate. The soil was what might be called a sandy clay, each pot holding 4,000 grams. The fertilizer was mixed with three-fourths of the soil of each pot. To the soil in each pot were added 0.25 gram of nitrogen, 0.30 gram of phosphoric acid and 0.20 gram of potash.

Results (Average of the Duplicates, expressed in Grams).

	Entire Plant.	Straw.	Chaff.	Grain.
Unmanured,	22.34	15.19	.95	6.20
Series I.				
Nitrogen.				
(*a*) Leather,	34.85	26.65	1.25	6.95
(*b*) Dried blood,	51.91	36.68	1.82	13.41
Series II.				
Nitrogen + Phosphoric Acid.				
(*a*) Leather + precipitated phosphate,	39.93	31.28	1.15	7.50
(*b*) Blood + precipitated phosphate,	51.97	36.45	1.91	13.61

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* *Loc. cit.*, 144 Centralbl. Agric. Chem., **10**, 590.

Series III.

	Entire Plant.	Straw.	Chaff.	Grain.
Nitrogen + Phosphoric Acid + Potash.				
(*a*) Leather + precipitated phosphate + muriate of potash.	30.55	21.90	1.09	7.56
(*b*) Dried blood + precipitated phosphate + muriate of potash.	37.40	29.65	1.82	15.93

In observing the results of the experiments we notice especially, with reference to the grain produced, that the leather did not increase the yield to any appreciable extent over that of the unfertilized pots. When phosphoric acid and potash were applied with the leather a slight increase in the yield of grain was noticed, while in case of the dried blood plus the phosphoric acid and potash the yield was twice that of the unfertilized pot.

Garden Experiments with Horse Beans.

The soil was the same as in the previous experiment. Size of plats, 60 square meters. The fertilizer applied was leather and nitrate of soda. Nitrogen was applied at the rate of 58.5 pounds per acre.

Results per Plat.

	Stems and Pods in Kilos.	Beans in Kilos.	Beans per Acre in Kilos.
Unmanured,	9,869	1,131	37,700
Leather,	12,822	1,178	39,268
Nitrate of soda,	11,465	2,035	67,832

It will be observed that the leather produced only a slight increase in the yield of beans.

Field Experiments with Sugar Beets.

Same soil as in previous experiments. Each plat measured one are. The fertilizer was applied at the rate of 42¼ pounds of nitrogen and 52.8 pounds of phosphoric acid per acre.

Results per Hectare.

	Kilos.	Percentage Increase over Unmanured.
Unmanured,	34,830	–
Soluble phosphoric acid,	34,380	—1.5
Water and citrate soluble phosphoric acid,	34,290	—1.2
Citrate soluble phosphoric acid,	34,380	—1.5
Unmanured,	33,840	–
Leather + soluble phosphoric acid,	37,890	11.9
Leather + water soluble + citrate soluble phosphoric acid	37,180	10.7
Leather + citrate soluble phosphoric acid,	35,910	6.0
Unmanured,	32,940	–
Nitrate of soda + soluble phosphoric acid,	43,380	28.1
Nitrate of soda + water + citrate soluble phosphoric acid.	42,070	24.2
Nitrate of soda + citrate soluble phosphoric acid,	43,830	29.4

While the leather has shown its effect, it runs far behind the nitrate of soda. Petermann says that from a financial stand-point the leather shows a loss and the nitrate of soda a gain. Of his results the experimenter makes the following résumé: "With horse bean the leather shows practically no influence the first year; with oats and sugar beets an increase is noted, but this is slight when compared with that from blood and nitrate of soda." In a later publication Petermann says that in his experiments from 1880 to 1885 the various forms of nitrogen have shown the following relative worth: 1, nitrate of soda; 2, blood; 3, dissolved wool; 4, ground bone; 5, raw wool; 6, leather.

Deherain * gives the results of the following experiments conducted in the field at Grignon with ground leather. The results with wheat in 1880 and 1881 show the residual effect of the leather applied to potatoes in 1879: —

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* *Chimie Agricole* (1892), 619.

	POTATOES.	WHEAT.			
	1879. Hectolitres.	**1880.** Grain (Qtm.).[*]	**1880.** Straw (Qtm.).	**1881.** Grain (Qtm.).	**1881.** Straw (Qtm.).
Unfertilized, . . .	224	25.0	37.25	16.4	20.5
Leather, 2,000 kilos., .	295	27.5	40.00	23.4	38.7
Leather, 1,000 kilos., .	277	25.0	38.00	23.0	37.6

Deherain remarks that his experiments make it clear that the leather yields its nitrogen very slowly. He does not state whether the leather used had been steamed, roasted or was untreated.

Müntz[†] and Girard, in connection with their experiments on the nitrification of various nitrogen-containing organic substances, carried out also a series of field experiments with various nitrogenous materials. Each plat had an area of one are and received 1.25 kilos. of nitrogen the first year, together with the necessary quantity of phosphoric acid and potash. No manure was applied the second year. The soil was light and sandy, being quite favorable to nitrification. The plats were planted with fodder corn during both years.

Fodder Corn grown upon One Are (Dry Matter).

FORM OF NITROGEN.	**1888.** Kilos.	**1889.** Kilos.	Average of Both Years.
Nitrate of soda, ...	143	47	190
Dried blood, ...	130	48	178
Roasted horn, ...	123	52	175
Roasted leather, ...	91	61	152
No nitrogen, ...	59	43	102

The above results show that leather, even when roasted, is quite inferior in its action to dried blood and nitrate of soda.

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[*] Qtm. (quintal metrique) = 100 kilograms.

[†] Ann. Agron., 17, 289-304; Biedermann's Centralblatt, **20**, 656.

Märcker * gives the following results obtained by Seyffert, at Halle, with cole-rape: —

FORM OF NITROGEN.	Yield in Grams.
No nitrogen,	75.5
Leather,	469.0
Steamed bone meal,	1,572.0
Blood,	1,654.0
Nitrate of soda,	2,607.5

In order to control the above experiment another test was carried out with oats by Julius Albert-Münchenhof: —

Yield.

FORM OF NITROGEN.	Grain (Grams).	Straw (Grams).	Roots (Grams).	Total (Grams).
No nitrogen,	5.2	15.7	14.3	38.2
Nitrate of soda,	48.9	62.6	27.9	139.4
Dried blood,	24.8	44.5	18.5	87.8
Leather,	13.3	22.2	13.6	49.1
Leather, fermented,	21.5	36.4	17.2	75.1

Märcker remarks that leather produced but a slight increase over the unfertilized, and that the quality of the grain was poorest when no nitrogen was used, or when leather was applied.

Dr. Wm. Frear very concisely presents the work done by Storer † as follows: —

Storer tested the manurial value of sheepskin and sole-leather, raw and roasted, on several soils in pots, applying various phosphatic and potassic salts in solution. The crop used was buckwheat. The results were as follows (expressed in weight of total crop in grams): —

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* Jahresbericht Agr. Chemie, 1883, 241.

† Bulletin Bussey Institution, 2, 58-71.

	With Rain-water.	With Sulphate of Potash.	With Phosphate of Potash.	With Phosphate of Potash and Nitrate of Lime.
No leather used: —				
In Berkshire sand, ...	.200	.200	.155	.665 *
In Provincetown sand, ...	.170	–	.165	3.050
In loam and sand, ...	.270	–	.160	5.830
Raw sheepskin (20): —				
In Berkshire sand (1,300), . . .	.100	.130	.055	.640 *
In Provincetown sand (1,450), . .	.080	–	.100	1.400
In loam and sand (1,320), . . .	.170	–	.120	4.020
Raw sole-leather (40): —				
In Berkshire sand (1,300), . . .	.110	.115	.120	.280
In Provincetown sand (1,450), . .	.120	–	.110	2.820
In loam and sand (1,320), . . .	.130	–	.150	3.720
Roasted sheepskin (20): —				
In Berkshire sand (1,300), . . .	.105	.190	.060	.250
In Provincetown sand (1,450), . .	.250 *	–	.470 *	.345 *
In loam and sand (1,320), . . .	.850	–	.700	3.060
Roasted sole-leather (40): —				
In Berkshire sand (1,300), . . .	.220 *	.230	.210 *	.360 *
In Provincetown sand (1,450), . .	.910	–	1.750	3.120
In loam and sand (1,320), . . .	2.120	–	1.980	4.785

* Immature when harvested.

Storer says: "It will be seen plainly enough that, while neither the sheepskin nor the sole-leather supplied any nitrogenous food to the buckwheat plants, some nitrogen was unquestionably obtained by the plants from the roasted leathers, a little from the roasted sheepskin and a decidedly larger amount from the roasted sole-leather. . . . In all cases the light, bulky material tended to interfere with the growth of the plants. The roasted-leather jars exhibited a marked growth of fungus, the raw-leather jars showed none, corroborating the evidence as to the existence of available products in the roasted leather. There is but little in the results above given to encourage the belief that roasted leather can have any definite money value as a manure."

Wagner * has made an exhaustive study of the value of different forms of nitrogen, having conducted 366 plat and pot experiments. The experiments were carried on for several successive years in a soil rich enough in lime to favor nitrification, and every effort was made to have the conditions equal in all cases. But a very brief résumé can be given at this time. One experiment was conducted for three successive years upon small plats of soil. Summer rye was planted the first year, summer wheat the second and carrots the third year. Placing the value of the returns from the nitrate of soda plats at 100, the other forms of nitrogen had the following relative worth : —

	First Year.	Average First and Second Years.	Average Three Years.
Nitrate of soda,	100	100	100
Blood,	67	67	69
Fish,	51	59	64
Steamed bone meal,	42	53	61
Leather,	13	12	20

Experiments were also conducted in pots with various soils, but the results cannot be noticed here.

In concluding his remarks relative to this subject Wagner says : —

> When I take all things into consideration, . . . I think I may present the following figures as an expression of the relative value of nitrogen in different forms of nitrogen-containing material : —

Nitrate of soda,	100
Sulphate of ammonia,	90
Blood, horn meal and green crops,	70
Fine-ground bone, fish and tankage,	60
Stable manure,	45
Wool dust,	30
Leather,	20

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* Die Stickstoff-düngung, etc., page 255.

So far as the writer has been able to ascertain, Wagner does not state the form of the leather used.

Taking the price of nitrogen in nitrate of soda at 14.8 cents, a pound of nitrogen in stable manure would be worth 6.7 cents and in leather 2.8 cents.

B. ARTIFICIAL DIGESTION EXPERIMENTS WITH LEATHER.

Stutzer and Klinkenberg were the first to propose this method. They argued that the amount of nitrogenous material that could be dissolved or digested would give a fairly correct idea of the value of the substance as a source of nitrogen for growing plants. They prepared the digestive fluid by extracting the inner lining of a pig's stomach, cut fine, with five litres of 0.2 per cent. hydrochloric acid for two days, filtering the solution, and preserving in glass-stoppered bottles, adding a few grams of salicylic acid to prevent fermentation. They submitted a variety of materials to the action of this solution. A few results are given below: —

SUBSTANCE.	Per Cent. of Nitrogen digested.
Blood,	89.75
Leather (cooked, and then roasted),	39.19
Raw bone,	98.70
Steamed bone,	90.50

Drs. Shepard and Chazal * afterwards submitted a great variety of nitrogen-containing materials to the action of Stutzer's solution. Several of the results obtained are presented below: —

	Per Cent. of Nitrogen digested.
Roasted leather meal,†	37.80
Dried blood (black),	78.61
Fish scrap,	88.67

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* See Report of Connecticut Experiment Station, 1885, page 117

† The authors remark that "this prepared leather was an excellent article, so far as preparation goes, and one capable of being used in the fertilizer trade without much fear of detection."

Johnson, Farrington and Winton,* instead of using Stutzer's solution, dissolved 5 grams of Golden Scale Pepsin in 1,000 cubic centimeters of 0.2 per cent. hydrochloric acid, and digested a variety of substances in this fluid. Their investigation is the most valuable we possess in this direction. A few of their results may be cited: —

	Per Cent. of Nitrogen digested.
Dried blood (two samples),	97.30
Dry ground fish,	71.20
Leather No. 3,†	23.40
Leather treated by benzine process,	35.90
Leather treated by superheated steam,	33.30
Mixed fertilizer A, containing 2.02 per cent. leather nitrogen,	23.40
Mixed fertilizer B, containing 2.00 per cent. leather nitrogen and 1.75 per cent. blood nitrogen,	55.60

In this connection it might be in place to mention the experiments recorded on the putrefaction of ammoniates, at first suggested by A. Morgen.‡ He put leather and horn meal in water to which a small amount of fecal extract had been added, and then allowed the solution to stand for thirty-one days at 30° C. The nitrogen made soluble was then estimated: —

In Experiment I., 10 grams material + 1,000 cubic centimeters water were used.

In Experiment II., 5 grams material + 1,000 cubic centimeters water + 5 cubic centimeters fecal extract.

In Experiment III. the same, with 10 grams material + 5 cubic centimeters fecal extract.

	Per Cent. of Soluble Nitrogen.
Leather meal, average of three experiments,	34.56
Horn meal, average of three experiments,	61.62

Johnson * repeated Morgen's work on a very large number of substances; a few of the results are given below. He allowed his solution to stand two weeks: —

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* *Loc. cit.*

† Fine and brittle, but method of preparation not known.

‡ Landw. Vers. Stat., 1880, **50**; Biedermann's Centralblatt, **9**, 801.

	Per Cent. Nitrogen Soluble.
Blood,	76.80
Fish,	78.10
Fish,	54.60
Bone,	79.00
Leather No. 3,	12.20
Steamed leather,	42.30
"Prepared ammoniate" (probably leather),	35.70

Johnson remarks that "this test of putrefaction draws the same line between those classes of ammoniates that was drawn by the pepsin digestion."

C. Nitrification Experiments with Leather.

These experiments were carried out by Müntz and Girard * with quite a number of nitrogen-containing substances. They were conducted in the laboratory, and care was taken to see that the soil was properly aired, and that moisture, temperature, etc., were favorable to the experiment. Ordinary soil was at first used, the amount of nitrates present being carefully noted, and a small amount of the substances to be nitrified then added. After a certain time the nitrates were washed out with water and estimated. A very short résumé is here presented: —

Nitrogen Nitrified, per 100 Parts of Nitrogen added to the Soil.

	I. Thirty Days.	II. Thirty-nine Days.	III. Thirty-two Days.
Sulphate of ammonia,	75.00	83.76	83.76
Dried blood,	72.44	73.56	84.50
Roasted horn,	71.03	73.17	46.82
Roasted leather,	11.62	16.47	13.26

In order to study the influence of different kinds of soil upon the process of nitrification, the experiment was repeated with soils from various sections of the country: —

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* Ann. Agron., **17**, 290; Agric. Science, **7**, 408–412. Deherain, *Chimie Agricole*, page 621.

Nitric Nitrogen found in Different Soils within a Certain Time.

	Light Soil of Joinville (Grams).	Chalky Soil (Grams).	Garden Earth (Grams).	Very Heavy Limey Clay (Grams).	Marsh Soil, Sour, Bretagne (Grams).
Sulphate of ammonia,	2.69	1.78	–	.510	None.
Blood, . . .	1.62	.73	–	.036	"
Roasted horn, . .	1.22	–	1.08	.029	"
Roasted leather, .	.41	.24	.55	.036	"

These experiments in general coincide with field and pot experiments as well as with artificial digestion experiments. It is worthy of note that the light sandy soil was most favorable to the process of nitrification, while the very heavy clay, and especially the sour marshy soil, was decidedly unfavorable to the action of nitrifying organisms.

II. Investigations concerning the Value of Leather Refuse made at this Station.

1. Can Leather be identified in Fertilizer Mixtures?

If one were to depend upon the microscope, it would certainly be an impossibility to recognize leather in finely ground fertilizer mixtures. Even if material of a fibrous structure were detected it would be nothing strange, for all flesh presents such a structure. After leather has been submitted to heat or pressure all structure is destroyed. Able microscopists, who have attempted to identify the leather under the microscope, report it an impossibility.

With chemical reagents one is more successful. At least, tannic or gallic acids, from their well-known reaction with an iron salt, are easily recognized; and, while one perhaps could not positively declare that the tannic or gallic acids present were derived from leather, it certainly would be highly probable.

Dr. C. W. Dabney,* when director of the North Carolina

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* North Carolina Experiment Station Bulletin, No. 3, 1883: Horn, Leather and Wool Waste.

Experiment Station, published a bulletin in which he suggests that the best reagent for recognizing the tannic acid is a phosphoric acid solution of phosphate of iron. He states that, if leather be present in the substance examined, a purple color will soon appear if a few drops of this solution be added to the alkaline solution of the leather extract. The phosphoric acid solution of phosphate of iron was prepared as follows: ten grams of ferric chloride were dissolved in water, and sodium phosphate added till all the iron was precipitated as phosphate of iron. The phosphate of iron must be freshly prepared, otherwise it will dissolve slowly, if at all. The phosphate of iron was filtered and washed quite thoroughly with water, and both filter and precipitate brought into a beaker containing 400 cubic centimeters of water, to which had been added 40 grams of glacial phosphoric acid. A gentle heat dissolves the iron phosphate quite readily.

If a drop of pyrogallic acid is added to water, the solution made slightly alkaline with ammonia and then a cubic centimeter of the iron phosphate solution added, a dark purple color appears. If tannic acid is substituted for the pyrogallic acid, a dark wine color results. In order to recognize leather in a mixture, a small amount (one gram) of the substance supposed to contain it is placed in a beaker with 30–40 cubic centimeters of water, a few drops of sulphuric acid added, the liquid brought to boiling, filtered, a little of the iron phosphate solution added, and the solution then made slightly alkaline with ammonia. If leather is present, a dark purple to wine color will soon appear.

Should leather be present in a mixed fertilizer containing soluble phosphate of lime, the latter will of course be precipitated on the addition of ammonia, but this in no way interferes with the color reaction. The writer examined during the summer of 1893 quite a number of fertilizers officially collected in Massachusetts, but in no case was leather to be detected. When, however, ten per cent. of leather was added to a mixed fertilizer, and then tested with the phosphate of iron solution, the dark color, due to the presence of tannic or gallic acids, very distinctly appeared.

During the early summer of 1893 several samples of leather were received at the station. It was stated that large quantities of the material were on the market, and one could surmise, at least, that it might be used as a source of nitrogen in the manufacture of commercial fertilizers, organic nitrogen at the time being quite high in price. It was thought wise to submit the samples to several tests, and, for the sake of comparison, pure sole-leather, obtained by the writer at the cobbler's, and dried blood were also included.

Description of the Samples.

I. Sole-leather. — This leather was ground fine for future tests. Under the microscope it showed a distinct fibrous structure. It contained 2.76 per cent. of fat and 7.94 per cent. of nitrogen.

II. Steamed Leather. — Some of the finely ground leather was placed in pressure bottles, water added, and heated for six hours at 110 ° C. The leather was virtually subjected to three atmospheres of steam pressure. After treatment it had become very dark in color, and appeared as a jelly-like, amorphous mass. The microscope showed it to be devoid of any fibrous structure. The tannic or gallic acids were still easily recognized, showing that they had not been destroyed by the heat and pressure. When dry it became quite brittle, crumbling easily.

III. Coarse Leather sent to the Station. — This leather came in pieces, from the size of a walnut to that of a small hen's egg. It contained 37.47 per cent. of fat and 4.52 per cent. of nitrogen. The large amount of fat completely concealed its structure.

IV. Philadelphia Tankage. — The sample was very finely ground and quite dry. It contained 1.95 per cent. of fat, 7.80 per cent. of nitrogen and traces only of phosphoric acid. Its smell and general appearance indicated clearly that it was leather that had been roasted or steamed. To the eye it appeared to be lacking in fibrous structure, and with the microscope it appeared simply as a gelatinous mass.

V. Dried Blood. — It was an excellent sample, containing 12.71 per cent. of nitrogen and .64 per cent. of fat.

2. *Artificial Digestion of Different Leathers.*

The artificial digestion of the substances above described was carried out according to Stutzer's method. In the first series of trials both the pepsin and pancreas solutions were used. The preparation of the pepsin solution has already been described.

The pancreas solution was prepared by taking the fresh pancreas of an ox, cutting it fine, mixing it with sand and allowing it to stand twenty-four to thirty-six hours exposed to the air. It was then rubbed with lime water and glycerine (to every 1,000 grams of the pancreas-sand mixture use 3 litres of lime water and 1 litre of glycerine of 1.23 specific gravity), and the resulting fluid allowed to stand with occasional stirring for five days. It was then filtered through cloth to remove the coarse portions, heated to 40° C. for two hours, and finally filtered through folded filters and preserved in bottles. To prepare the pancreas solution used in the process of digestion, 250 cubic centimeters of the above-described solution were mixed with 750 cubic centimeters of soda solution. The soda solution contained 5 grams of carbonate of soda dissolved in 750 cubic centimeters of water. The pancreas solution thus prepared was heated for one to two hours at 37°–40° C., filtered to remove any flocky precipitate, and 100 cubic centimeters used for each test.

The results of the pepsin-pancreas digestion were as follows: —

		Per Cent. of Nitrogen digested.
I.	Sole-leather finely ground,	80.98
II.	Same leather after being heated six hours at 110° C. in pressure bottles with water,	97.23
III.	Coarse leather (free from fat),	52.00
IV.	Philadelphia tankage,	90.64
V.	Dried blood,	99.13

The above results are all very high, but this is not surprising, for the action of dilute alkalies on leather is well known and has been several times referred to. In the present case, after the various leathers had been submitted to the pepsin digestion there appeared to be no very great change either in their appearance or bulk. Blood, on the other hand, was nearly all dissolved by the pepsin solution. As soon, however, as the leathers were submitted to the action of the pancreas solution a decided change was noted; the solution became quite dark in color and the larger part of the leather went into solution. While this method indicated a greater availability on the part of the sole-leather *after it had been submitted to steam pressure*, it nevertheless did not give a correct idea of the digestibility and consequent availability of the leather when compared with the dried blood.

The substances were therefore submitted to the action of the pepsin solution alone, with results as follows: —

		Percentage Digestibility of Nitrogen.
I.	Sole-leather,	13.70
II.	Sole-leather after steam pressure,	34.40
III.	Coarse leather,	–
IV.	Philadelphia tankage,	42.30
V.	Dried blood,	97.80

These results coincide very closely with those obtained by other investigators. The sole-leather itself proved very indigestible. It is possible that it might have proved somewhat less so if no hydrochloric acid had been added during the digestion.* The sole-leather *after* being subjected to the action of the steam pressure had a digestibility of 34.40 per cent., which coincides with results obtained by others for prepared leather, as the following samples show: —

	Percentage of Nitrogen digested.
Leather cooked and roasted (Stutzer),	39.19
Roasted leather meal (Shepard and Chazal),	37.80
Leather by benzine process (Johnson),	35.90
Leather by superheated steam (Johnson),	33.30

While, then, the action of steam and heat renders the leather somewhat more digestible and probably more available in the soil, it still has a digestibility below 50 per cent. Only the very poorest kinds of animal matter reach this low figure (50). The so-called Philadelphia tankage was also below 50 per cent. digestible, and may be classified with the steamed or roasted leathers as regards its value. It is to be noted, as before mentioned, that the dried blood was nearly all digested by the action of the pepsin solution, and may be regarded as a very excellent standard with which to compare the various leathers.

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* Connecticut Experiment Station, 1886, page 122.

General Conclusions relative to Raw, Roasted or Steamed Leather.

The results of the combined experiments in the field and in pots, together with artificial digestion experiments, and nitrification experiments, indicate that leather, either raw, roasted or steamed, is a very slow-acting form of nitrogen as a source of plant food. It certainly would be fraudulent to sell it in mixed fertilizers as a source of organic nitrogen, and the Massachusetts fertilizer law distinctly forbids it to be thus utilized. Carefully conducted experiments by Wagner give it a relative value of twenty, nitrate of soda being equal to one hundred. From the mass of evidence at our command it would seem that this figure about expresses its relative worth as a direct source of plant food. If it is offered for sale as a fertilizer, it should be sold as leather. When nitrogen in organic matter has a value of sixteen to eighteen cents per pound, nitrogen in raw, steamed or roasted leather should be worth but three to six cents per pound.

3. Action of Sulphuric Acid on Leather.

Deherain and others suggest that if leather be dissolved in sulphuric acid its nitrogen will be made as valuable as that in any form of animal matter. No experiments, however, are brought forward to prove such a statement, but it is generally understood that many European manufacturers thus turn leather waste to account. In order to study this question more closely a number of experiments were carried out by the writer, a few of which are presented below: —

Experiment I. — Sixty-five grams of 50° B. sulphuric acid were heated in a porcelain dish over a water bath of about 90° C., and 12 grams of leather gradually added. A dark, thick fluid resulted. Thirty cubic centimeters of water were then added to dilute the thick fluid somewhat, and bone ash was employed to dry off the resulting semi-fluid mass.

One hundred and thirty-six grams of superphosphate were obtained, which gave no tannic acid reaction.

Experiment II. — To 30 grams of 50° B. sulphuric acid, heated as above described, were added 12 grams of leather. A dark, thick paste was obtained, to which were added 25 cubic centimeters of water and 33 grams of bone ash. Seventy-three grams of superphosphate were obtained. The reaction of tannic acid was not strong.

Analyses of the two products were made as follows: —

	I. Per Cent.	II. Per Cent.
Moisture,	18.03	15.59
Soluble phosphoric acid,	14.84	11.80
Reverted phosphoric acid,	.69	1.50
Insoluble phosphoric acid,	1.43	3.38
Total phosphoric acid,	16.96	16.68
Nitrogen,	.70	1.20

Experiments III., IV., V., VI. — The previously described Philadelphia tankage was used in these experiments, and South Carolina floats in place of bone ash. The objects in view were to see (*a*) how much leather could be used without giving a tannic acid reaction, (*b*) to note, if possible, to what extent the leather interfered with the action of the sulphuric acid upon the floats, (*c*) to notice the approximate percentage of available phosphoric acid and nitrogen resulting, (*d*) to see if any nitrogen in the resulting superphosphates was soluble in water, (*e*) to note the amount of nitrogen in the superphosphate artificially digestible by Stutzer's solution. To make this latter estimation (*e*), 5 grams of superphosphate were stirred with water, filtered, and washed till the wash water was no longer acid. The portion not soluble in water was treated with pepsin solution.

Experiment III. — To 30 grams of 50° B. sulphuric acid, after heating, previously described, were added 12 grams of Philadelphia tankage. A thick, black dough resulted. It was diluted with 25 cubic centimeters of water, appearing then as a thick, black fluid. To this fluid were added 60 grams of floats. The resulting superphosphate, after drying in the air for twenty-four hours, weighed 102 grams. The tannic acid reaction was quite strong.

Experiment IV. — To 30 grams of 50° B. acid were added 25 cubic centimeters of water and 70 grams of floats. The dry superphosphate weighed 101.5 grams.

Experiment V. — To 30 grams of 50° B. acid were added 9 grams of Philadelphia tankage, which resulted in a medium thick paste. Twenty cubic centimeters of water and 48.5 grams of floats were afterwards added. The dry superphosphate weighed 88 grams, and gave *no* tannic acid reaction.

Experiment VI. — To 30 grams of 40° B. acid 9 grams of Philadelphia tankage were added, resulting in a medium thick paste. This paste was diluted with 20 cubic centimeters of water, and 50 grams of floats were put in. Seventy-nine grams of superphosphate were obtained, which gave a strong tannic acid reaction.

These several products were analyzed : —

	III. Per Cent.	IV. Per Cent.	V. Per Cent.	VI. Per Cent.
Moisture,	14.14	14.13	14.86	–
Soluble phosphoric acid,	6.78	7.30	7.80	–
Reverted phosphoric acid,	1.22	1.60	.44	–
Insoluble phosphoric acid,	5.50	6.66	4.94	–
Total phosphoric acid,	13.50	15.56	13.18	–
Total nitrogen,	.81	–	.87	1.03
Nitrogen after artificial digestion,	.37	–	.25	.41
Per cent. of total nitrogen digested,	54.00	–	71.00	60.00
Soluble nitrogen,	trace	–	trace	–

It would appear that 9 grams of leather were all that could be added to 30 grams of sulphuric acid without getting the tannic-acid reaction. When, as in Experiment III., 12 grams of leather were added, the reaction for tannic acid was quite marked, and the nitrogen in the superphosphate had a digestibility of but 54 per cent. Experiment VI. indicates that 40° B. sulphuric acid was not quite strong enough to thoroughly disintegrate the 9 grams of leather, for the tannic acid in the superphosphate was easily recognized, and the nitrogen was but 60 per cent. digestible. When 9 grams of the Philadelphia tankage were dissolved in 30 grams of 50° B. acid, no tannic acid could be recognized, and 70 per cent. of the total nitrogen was digestible. This is probably the average percentage of organic nitrogen that would be found digestible in mixed fertilizer, as offered for sale in our markets. Such a result is quite encouraging. It would seem from the analysis of IV. that the leather had not seriously interfered with the action of the sulphuric acid upon the floats. We have in the four experiments above cited added rather too much phosphate rock and water, and in the two following experiments less were added.

Experiment VII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, and then 12 cubic centimeters of water. To the thick fluid resulting 41 grams of floats were added. After standing twenty-four hours the material could be easily handled, and weighed 71.5 grams.

Experiment VIII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, producing a thick, pasty mass. Without the addition of water 28 grams of floats were stirred in, and after twenty-four hours the mass weighed 63 grams. The phosphate was quite black in color and sticky. It needed at least 5 to 7 grams more floats before it could be easily handled. It was plain that the sulphuric acid was not all neutralized. If no water were added to dilute the thick, pasty mass, it would be very difficult to work in the floats should large quantities be mixed.

Analyses.

	VII. Per Cent.	VIII. Per Cent.
Moisture,	17.95	16.95
Soluble phosphoric acid,	6.79	5.99
Reverted phosphoric acid,	2.16	1.62
Insoluble phosphoric acid,	1.94	1.56
Total phosphoric acid,	10.89	9.17
Total nitrogen,	.90	1.06

In Experiment VII. 8.95 per cent. of available phosphoric acid was obtained, with but 1.94 per cent. of insoluble acid and .90 per cent. of nitrogen; the phosphate was also in good mechanical condition and gave no tannic-acid reaction. The proportions of water, sulphuric acid, floats and leather appear to be about correct, and the percentages of available phosphoric acid and nitrogen as high as could be expected, with floats as a dryer.

Experiment IX. — In experiments III. to VIII. Philadelphia tankage was used as a source of leather.

In this experiment pure fine-ground sole-leather was used, to see if the sulphuric acid acted as strongly upon the pure leather as upon the prepared article. To 30 grams of 50° B. acid were added 9 grams of sole-leather, 20 cubic centimeters of water and 60 grams of floats.

The resulting phosphate weighed 98.5 grams.

Analysis gave the following results: —

	Per Cent.
Total nitrogen in the superphosphate,	.710
Total nitrogen after digestion,	.220
Total nitrogen digested,	69.000
Nitrogen soluble in water	.047
Per cent. of soluble nitrogen,	6.620

No tannic acid could be detected in this superphosphate. The artificial digestion of the nitrogen was made by taking 5 grams of the substance, washing out the soluble phosphoric acid with water, and proceeding in the usual manner.

It is to be noted from the above figures that the nitrogen in the sole-leather thus treated was as digestible as is the average animal matter sold for fertilizing purposes.

Practical Deductions.

The various experiments made would indicate that leather, sulphuric acid, water and floats should be mixed in about the following relative proportions: —

	Pounds.
Sulphuric acid, 50° B.,	2,000
Ground leather,	600
Water,	800
Floats,	2,700

The resulting mixture, when in fairly dry condition, would weigh approximately 5,000 pounds, shrinking about 18 to 20 per cent. It would have approximately the following composition: —

	Per Cent.
Moisture,	18.00
Available phosphoric acid,	8.50
Insoluble phosphoric acid,	2.00
Total phosphoric acid,	10.50
Total nitrogen,	.90

Two thousand pounds of sulphuric acid will not take up more than 600 pounds of leather and render the leather 70 per cent. digestible. If more is added, part of the latter, whether roasted or raw, will not be thoroughly acted upon by the acid. With 600 pounds of leather a thick paste results, which must be diluted somewhat with water in order to allow the sulphuric acid to act freely upon the floats. If bone ash should be used as a dryer, in place of ground phosphate rock, a higher percentage of available phosphoric acid and of nitrogen would result, as experiments I. and II. indicate.

Before submitting the leather to the action of the sulphuric acid, it would undoubtedly be better, after extracting the fat, to steam or roast it, in order that it may be easily pulverized. Raw, untreated leather is ground only with difficulty, and if the mechanical condition of the leather were poor, the action of the sulphuric acid would be imperfect.

POT EXPERIMENTS WITH DISSOLVED LEATHER.

By J. B. LINDSEY AND R. H. SMITH.

In order to still further study the availability of the nitrogen in dissolved leather, pot experiments were instituted, and the result of our first year's trial is here presented.

The Pots used.

The pots were made of thin galvanized iron, and were seven and three-quarters inches in diameter and eight inches deep. A galvanized-iron tube, half an inch in diameter, extended from the top to the bottom of the pot, connecting at the base with a second tube of the same material, one inch in diameter. This latter tube extended along the bottom of the pot and was perforated with small holes. The object of these tubes was to supply water partially from the bottom.

The Soil.

In order to test the availability of different sources of nitrogen, the soil to be used for such a purpose should be as poor in this ingredient as possible. If not naturally in such a condition, it should be rendered so by previous cropping. As we had not an ideal soil at hand for such a purpose, a sandy subsoil was selected that was poor in all of the several ingredients of fertility. It had the following composition: —

	Per Cent.
Moisture when tested,	14.25
Phosphoric acid,	.13
Potassium oxide,	.08
Nitrogen,	.09

The Fertilizers used.

In order to turn the nitrogen to the very best account, phosphoric acid and potash must be supplied in excess.

The sources of nitrogen were nitrate of soda, dissolved leather and Philadelphia tankage. The Philadelphia tankage has already been described. The dissolved leather was prepared as follows: to 210 grams of c. p. sulphuric acid of 50° B., heated to 80° C., were added 63 grams of finely ground sole-leather. The mixture was thoroughly stirred, and allowed to stand for half an hour; a dark pasty mass resulted. Forty-nine grams of water were added to thin the paste somewhat, and then finely ground calcium carbonate (marble) was added, to take up the excess of sulphuric acid, and enable us to secure a dry, easily handled material. We used the carbonate instead of the phosphate of lime as a dryer, in order to avoid an excess of phosphoric acid. After standing twenty-four hours the substance had dried out sufficiently to be easily handled and ground.

Double superphosphate was used as a source of phosphoric acid, and the potash was applied in the form of the double sulphate of potash and magnesia.

Composition of the Fertilizers.

	Dissolved Leather.	Philadelphia Tankage.	Nitrate Soda.	Double Superphosphate.	Sulphate of Potash and Magnesia.
Moisture,	-*	-*	2.09	5.74	8.10
Nitrogen,	.97	7.80	14.28	-	-
Soluble phosphoric acid,	-	-	-	38.38	-
Reverted phosphoric acid,	-	-	-	9.04	-
Available phosphoric acid,	-	-	-	47.42	-
Insoluble phosphoric acid,	-	-	-	.38	-
Total phosphoric acid,	-	-	-	47.80	-
Potassium oxide,	-	-	-	-	24.32

* Not determined.

Arrangement of the Experiment.

Eighteen pots were used in the experiment, fertilized as follows: —

POTS.	Source of Nitrogen.	Amount of Nitrogen applied (Grams).	Amount of Available Phosphoric Acid applied (Grams).	Amount of Potassium Oxide applied (Grams).
Pots 1, 2, 3,	Soil nitrogen,	-	1.20	2.40
Pots 4, 5, 6,	Philadelphia tankage,	.60	1.20	2.40
Pots 7, 8, 9,	Nitrate soda,	.30	1.20	2.40
Pots 10, 11, 12,	Nitrate soda,	.60	1.20	2.40
Pots 13, 14, 15,	Dissolved leather,	.30	1.20	2.40
Pots 16, 17, 18,	Dissolved leather,	.60	1.20	2.40

Pots 1, 4, 7, 10, 13, 16 were infected with a small quantity of cultivated soil, in order to note if the infection facilitated the nitrification of the organic nitrogen in case of our experiments. To each of these pots were also added 10 grams of air-slacked lime.

Filling the Pots.

About an inch of good clean gravel was first added to the pots, and then five centimeters of the well-mixed soil (three and one-half pounds). The fertilizer (one-half of the nitrate of soda only at this time) was then thoroughly mixed with six and one-half pounds of the soil and added; this addition increased the depth nine centimeters. Two pounds of the mixed soil (three centimeters) were next put in, and finally the oats (one gram of seed per pot) were scattered in and covered with one-half pound of the soil. Twelve and one-half pounds of soil were therefore added to each pot, and filled it to within one centimeter of the top. After each addition of soil the pot was somewhat shaken, but the soil was not at all pressed in. The filling and planting were completed on April 25.

General Care of the Experiment.

The pots were set into a wagon running on an iron track. The floor of the wagon was surrounded with sides six inches deep. The space between the pots was filled with sawdust, which was kept moist, in order to keep the soil in the pots as cool as possible during the hot summer weather. The pots were carefully watched and kept sufficiently watered. A portion of this water was supplied from beneath, and the remainder was added to the surface with a sprinkling pot. Sometimes it became necessary to water twice daily. The pots were kept in the open whenever the weather permitted. During wet or windy weather, and at night, they were run under cover.

Notes.

The oats appeared April 30. When they were about two inches high, twelve plants were removed from each pot, as they appeared rather thick.

Appearance June 1.

Pots 1, 2, 3. Oats were eleven to thirteen inches high. They began to appear light green, up to yellow, and spindly.

Pots 4, 5, 6. Oats were but very little better in appearance than those in pots 1, 2 and 3.

Pots 7, 8, 9. Plants were dark green, stocky, and eleven to thirteen inches high.

Pots 10, 11, 12. Plants appeared dark green, very stocky, and were eleven to fifteen inches high.

Pots 13, 14, 15. Leaves broad, very dark green, and plants twelve to fifteen inches high.

Pots 16, 17, 18. Same as pots 13, 14, 15.

On June 4 pots 7, 8, 9 began to show nitrogen hunger, by appearing a lighter green; the ends of the leaves were turning yellow. The other half of the nitrate of soda was therefore added in 350 cubic centimeters of water to pots 7, 8, 9, 10, 11 and 12. From this time on (June 4) the plants in pots 1, 2, 3, 4, 5 and 6 grew quite slowly, had a light-green and spindly appearance. On June 22 the oats in all the pots (excepting 10, 11, 12) began to head. The latter showed the heads about a week later.

The plants retained their same relative appearance till harvested.

The plants in pots 10, 11, 12 were a deep rich green and stocky, but failed to mature much grain, as our tabulated results will show.

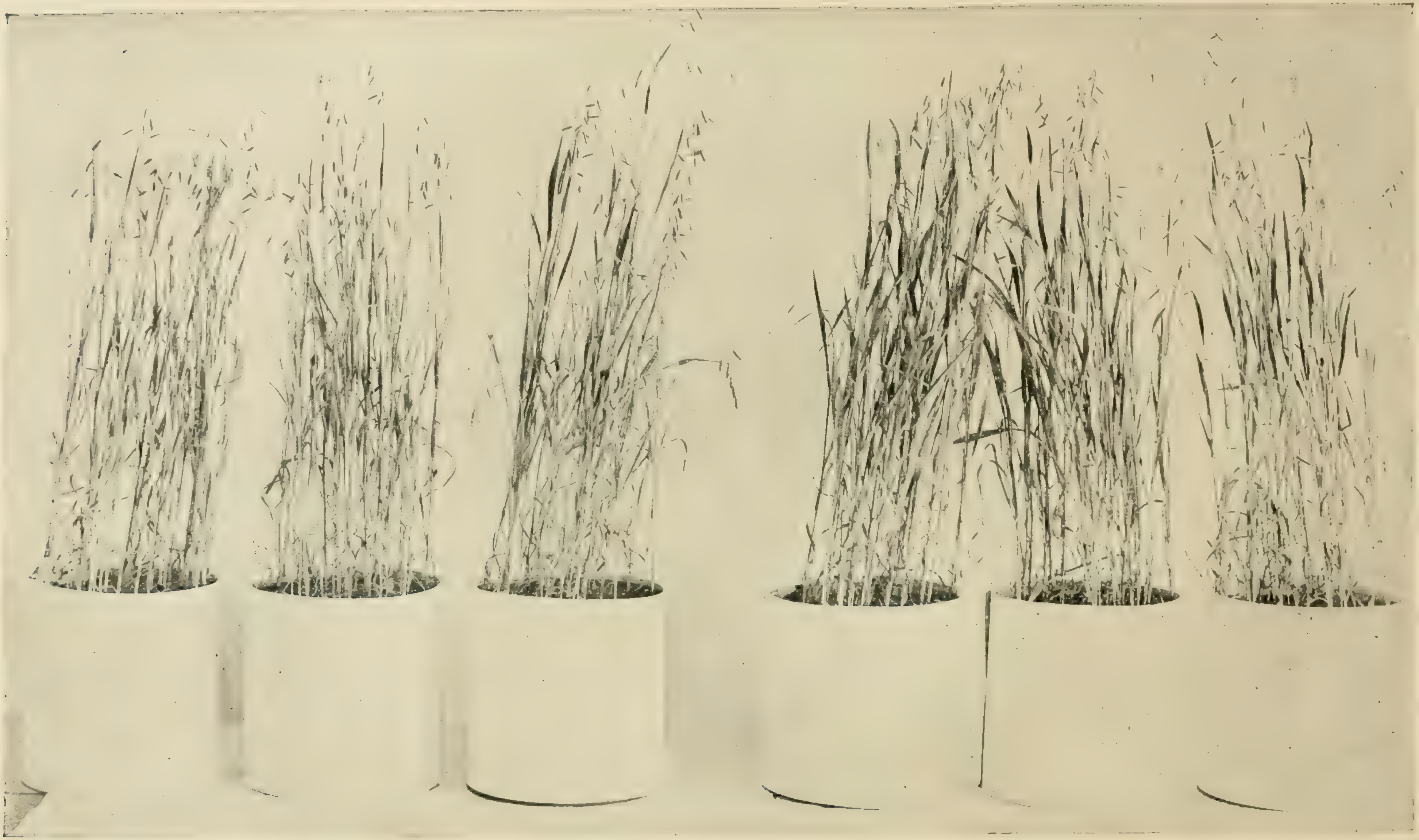
Harvesting.

The plants were harvested as they matured. The oats in pots 1, 2, 3 were cut, for example, July 23, while those in pots 10, 11, 12 not till August 10. They were cut close to the soil, put in large paper bags, and hung away to dry.

The photographs that follow show the relative appearance of the plants in pots 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 14, 15, a short time before harvesting. The photographs of the plants in pots 10, 11, 12, 16, 17, 18 are not presented, for reasons that will be stated further on.

Comments.

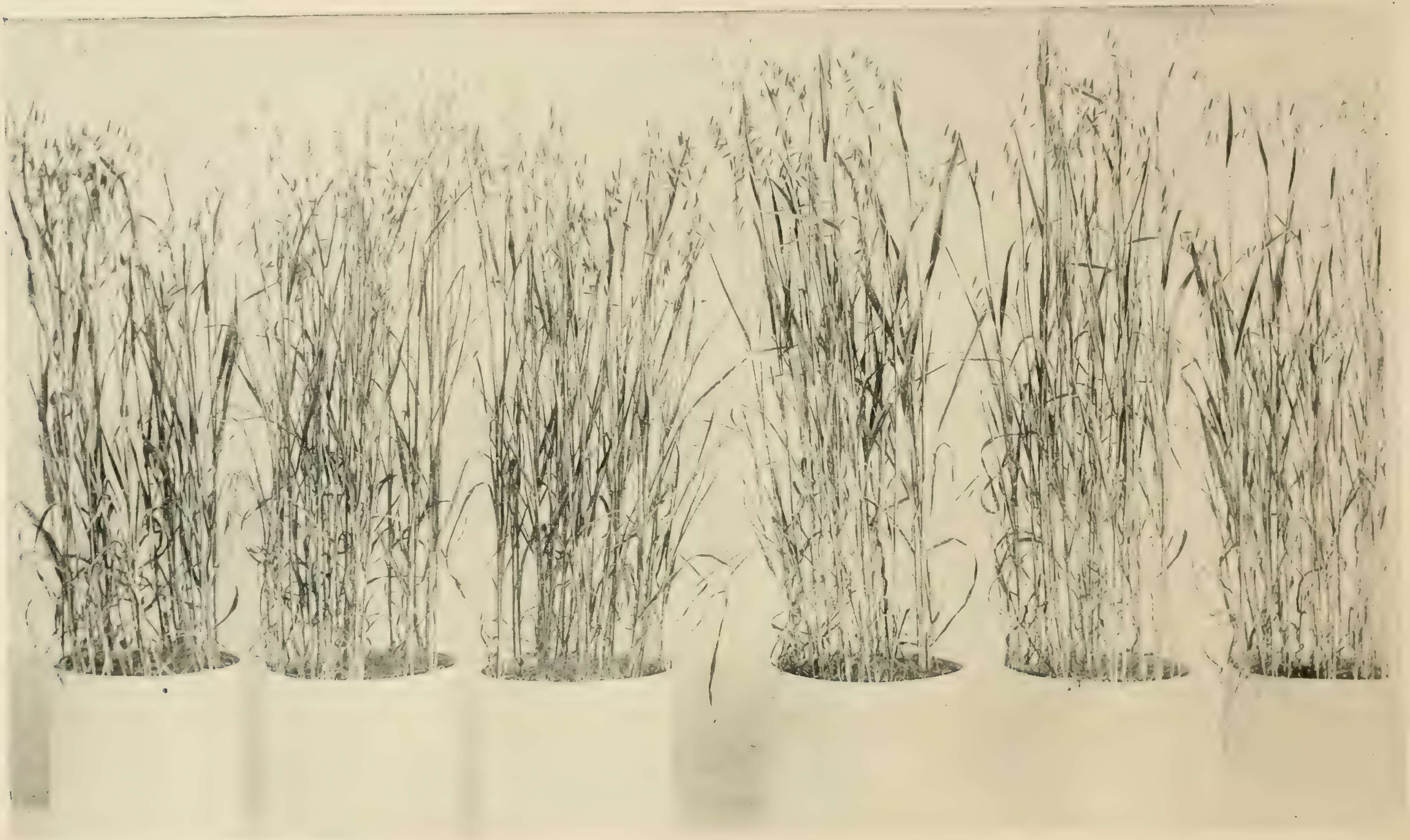
Pots 1, 2, 3, 4, 5, 6 (see first photograph) have the same general appearance, though the latter contain a trifle more foliage. Pots 7, 8, 9, fertilized with .30 grams of nitrogen from nitrate of soda, and pots 13, 14, 15, with the same amount of nitrogen in the form of dissolved leather (see second photograph), compare to the eye very favorably one with the other. The plants in the nitrate pots are not quite as tall, but more stocky.



OATS.

0.00 g. nitrogen + phosphoric acid + potash.

0.600 g. nitrogen from Phil. tankage + phosphoric acid + potash.



OATS.

0.300 g. nitrogen from nitrate soda + phosphoric acid + potash.

0.300 g. nitrogen from dissolved leather + phosphoric acid + potash.

The Results.

After the product from each pot was thoroughly air dry, the grain was carefully removed, weighed, coarsely ground, and dry-matter determinations made. The straw was cut into short lengths, and together with the chaff tested for dry matter. Finally, both grain and straw were ground fine, and nitrogen determinations made.

Table I.

FORM OF NITROGEN.	Quantity of Nitrogen added to Each Pot (Grams).	DRY MATTER YIELDED BY SINGLE POTS.		AVERAGE DRY MATTER FROM THREE POTS.		GAIN IN DRY MATTER OVER SOIL NITROGEN POTS, ON BASIS OF .30 GRAM OF NITROGEN APPLIED.		IF GAIN IN DRY MATTER WITH NITRATE SODA EQUAL 100, THEN OTHER SOURCES OF NITROGEN WOULD BE EQUAL TO —		Average of Straw and Grain.
		Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw.	Grain.	
Soil nitrogen,	.00	7.777	1.893	7.82	1.69	-	-	.00	.00	-
	.00	7.683	1.598							
	.00	8.013	1.569							
Philadelphia tankage,	.60	9.524	1.171	8.88	1.66	.53	±	5.40	±	2.70
	.60	8.447	.899							
	.60	8.684	2.906							
Nitrate of soda,	.30	16.624	6.155	17.59	6.37	9.77	4.68	100	100	100
	.30	18.126	6.969							
	.30	18.021	5.986							
Dissolved leather,	.30	15.245	4.348	14.35	4.25	6.53	2.56	66.8	54.7	60.7
	.30	14.454	4.663							
	.30	13.362	3.728							
Nitrate of soda,	.60	19.521	2.197	19.54	1.85	-	-	-	-	-
	.60	20.275	1.682							
	.60	18.813	1.679							
Dissolved leather,	.60	19.933	4.350	19.76	4.92	-	-	-	-	-
	.60	18.723	5.223							
	.60	20.623	5.197							

Comments on Table I.

The first four columns in the table show the weight of straw and grain (dry matter) produced by each pot, and the average from each three pots. The next three columns indicate the gain in dry matter over those pots containing only soil nitrogen. Then follow the comparative yields, nitrate of soda being rated at 100. When the average of both straw and grain is considered, it will be seen that the dissolved leather yielded 60.7 per cent. as much as the same quantity of nitrogen in the form of nitrate of soda. The Philadelphia tankage, on the other hand, gave but a slight increase over the no-nitrogen pots; this slight gain was in the yield of straw.

In case of the last six pots, where .60 gram of nitrogen was applied in the forms of nitrate of soda and dissolved leather, we find a large amount of straw produced, but very little grain. This, in all probability, can be attributed to two causes: in the first place, in case of the nitrate of soda, one-half the quantity was not applied till early June, and this application might have been too late to enable the plants to take it up and work it over into grain; in the second place, there might not have been phosphoric acid and potash enough present to have enabled the plants to turn the nitrogen to account. Twice as much phosphoric acid and four times as much potassium oxide as nitrogen were applied; the coming year these amounts will be doubled, in order to make sure that a sufficient quantity is present. The results from these latter pots, therefore, are simply stated, but not further considered.

Table II.

FORM OF NITROGEN.	Quantity Nitrogen to Each Pot (Grams).	Nitrogen in Total Dry Matter produced (Grams).	NITROGEN IN 100 GRAMS DRY MATTER (GRAMS).		For Every 100 Parts of Nitrogen applied, there has been returned in Straw and Grain —	When Nitrate Soda equals 100, Other Sources of Nitrogen equal to —	EVERY GRAM OF NITROGEN APPLIED HAS PRODUCED IN DRY MATTER —			For Every 100 Parts of Straw, there has been produced in Grain —
			Straw.	Grain.	(Parts.)		Straw (Grams).	Grain (Grams).	Straw and Grain (Grams).	
Soil nitrogen,	.00	.0945	.68	2.604	-	-	-	-	-	21.60
Nitrate of soda,	.30	.3050	.78	2.716	70	100	32.57	15.60	48.17	36.20
Dissolved leather,	.30	.2100	.68	2.660	39	56	21.77	8.53	30.30	29.60
Philadelphia tankage,	.60	.1260	.96	2.510	5.3	7.6	.88	-	.88	18.69
Nitrate of soda,	.60	.4250	-	-	55	-	-	-	-	-
Dissolved leather,	.60	.3250	-	-	39	56	-	-	-	-

Comments on Table II.

The first two columns show the sources of nitrogen and the quantity applied to each pot. The third column shows the total average nitrogen found in the dry matter produced by each pot. Where no nitrogen was applied, the soil yielded of itself .0945 gram, and the excess over this amount obtained in the other series represents the amount that the plants succeeded in getting from the nitrogen applied. The next column shows that for every 100 parts of nitrogen applied in the form of nitrate of soda 70 parts were obtained in the grain and straw; the other 30 parts would probably largely if not entirely be found in the roots. For every 100 parts of nitrogen applied in the form of dissolved leather 39 parts were returned, while for every 100 parts applied in the form of Philadelphia tankage but 5.3 parts were recovered. The next column shows that, if the amount of nitrogen returned in case of the nitrate of soda pots be represented by 100, then the amount returned in case of dissolved leather would be 56, and in case of Philadelphia tankage 7.6. The last column indicates the parts of grain produced for every 100 parts of straw. Notice that where no nitrogen was applied only 21.6 parts of grain were produced to 100 parts of straw; but when .30 gram of nitrogen in form of nitrate of soda was added, 36 parts of grain were obtained to 100 parts of straw.

Résumé. — Action of Sulphuric Acid on Leather.

Artificial digestion tests show that nitrogen in either raw, steamed or roasted leather, after being acted on by 50° B. sulphuric acid, has a digestibility of 70 per cent. This test would class it, as regards availability, with the average quality of animal matter sold for fertilizing purposes.

The result of our first year's test with pot experiments indicates that, when nitrate of soda as a source of nitrogen is rated at 100, the nitrogen in the form of dissolved leather would be rated at about 60. The return from the Philadelphia tankage was very slight. The experiment will be continued the coming year.

12. Report on General Farm Work (1894).

The lands assigned for the use of the Massachusetts State Agricultural Experiment Station cover an area of fifty acres. Ten acres are natural woodlands, and forty acres, including the space occupied by the buildings, are used for the raising of farm crops. At present from fifteen to sixteen acres are under cultivation, and from sixteen to seventeen acres are permanent grass lands. As every portion of the land is at present serving for some special experiment, the general management of the farm is to a controlling degree subjected to the requirements of the work called for in connection with the various questions under investigation. The adoption of a thorough mechanical preparation of the soil, supported by a careful, clean cultivation of the crops raised, has brought the lands into a fair condition for field experiments. Each field has had for years its own system of manuring, and becomes thereby from year to year more valuable for experimental purposes. Wherever circumstances have been favorable, forage crops have been chosen, for the purpose of studying the influence of various systems of fertilization and cultivation on their growth and special character. This practice has resulted already in the successful introduction of some valuable forage plants new to our locality, and has also materially assisted us in an economical support of quite extensive experiments in stock feeding. The beneficial effect of many of these crops on the physical and chemical condition of our cultivated lands is everywhere noticed, when compared with their previous general condition.

During the past season soja bean, vetch and oats, vetch and barley, and vetch, oats and horse bean have been raised. The vetch and oats was fed in part green and the remainder was converted into hay for dairy cows. The soja bean was used in a mixed silage with corn. The vetch and barley and vetch, oats and horse bean were used for hay.

Twenty-six tons of corn have been put into the silos, about three to four tons being in the form of mixed silage with soja bean. Of the remainder, part was fed green and the rest harvested at maturity.

During the past season the area of the orchard has been laid down in permanent grass land. From three to four feet space around each tree has been left open for cultivation.

The amount and character of farm and garden crops raised in 1894 may be seen from the following statement: —

	Tons.
Hay (first cut),	33
Rowen,	6½
Potatoes,	6½
Oats (756 pounds grain, 2,224 pounds straw),	1½
Vetch and oats (hay),	3¾
Vetch and oats (green),	3½
Vetch and barley (hay),	9/10
Vetch, oats and horse bean (hay),	½
Fodder corn (green),	29
Soja bean (green),	3⅓
Hungarian grass (green),	2⅕
Barley (657 pounds grain, 1,378 pounds straw),	1
Rye (2,576 pounds grain, 11,072 pounds straw),	6¾
Tomatoes,	2¼
Onions,	7/10
Carrots,	2¼
Globe mangolds,	1 9/10
Spinach,	½
Lettuce,	⅕
Miscellaneous,	3
	109⅙

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

C. A. GOESSMANN.

I. COMMUNICATION ON COMMERCIAL FERTILIZERS: —
  1. GENERAL INTRODUCTION.
  2. STATE LAWS FOR THE REGULATION OF TRADE IN COMMERCIAL FERTILIZERS.
  3. LIST OF LICENSED MANUFACTURERS AND DEALERS FROM MAY 1, 1894, TO MAY 1, 1895 (58).
  4. ANALYSES OF LICENSED FERTILIZERS (253) (COMPILED BY H. D. HASKINS).
  5. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION (145) (COMPILED BY C. S. CROCKER).
  6. MISCELLANEOUS ANALYSES (4) (COMPILED BY C. S. CROCKER).
  7. MISCELLANEOUS FODDER ANALYSES (69) (COMPILED BY C. S. CROCKER).

II. ANALYSES OF MILK SENT ON FOR EXAMINATION (40) (COMPILED BY C. S. CROCKER).

III. ANALYSES OF WATER SENT ON FOR EXAMINATION (200) (COMPILED BY R. H. SMITH).

IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES (COMPILED BY C. S. CROCKER).

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I.

COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.
7. Miscellaneous fodder analyses.

1. General Introduction.

Fifty-eight manufacturers and dealers have applied for and received licenses for the sale of their various brands of fertilizers in our State. Twenty-five of them are residents of other States.

Two hundred and seventy-four samples of licensed articles have been collected in all parts of the State by an authorized agent of the station.* Two hundred and fifty-three of them have been carefully analyzed at the chemical laboratory of the station, with the following results: four samples contained all three essential constituents above the highest guarantee; twenty-five contained two of the essential elements above the highest guarantee; seventy contained one essential element above the highest guarantee; thirty-four contained three essential elements above the lowest guarantee; seventy-four contained two essential elements above the lowest guarantee; eighty-seven contained one element above the lowest guarantee; one contained three essential elements below the lowest stated guarantee; seventeen contained two essential elements below the lowest stated guarantee; seventy-six contained one element below the lowest stated guarantee. The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others.

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* Mr. H. D. Haskins, a graduate of the Massachusetts Agricultural College, of the class of '90, and for four years past an assistant in the chemical laboratory of the Massachusetts State Experiment Station.

The variations in the market price of prominent fertilizer constituents have been, on the whole, during the past year within the usual limits. Potash in its different forms, as well as nitrogen, has advanced in price compared with last year's quotations, while phosphoric acid has remained about the same.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate*, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws*, *and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not infrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value*, *i. e.*, their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information, namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, *i. e.*, phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (*i. e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1894.

	Cents per Pound.
Nitrogen in ammonia salts,	19
Nitrogen in nitrates,	14½
Organic nitrogen in dry and fine-ground fish, meat, blood, and in high-grade mixed fertilizers,	18½
Organic nitrogen in cotton-seed meal, linseed meal and castor pomace,	15
Organic nitrogen in fine-ground bone and tankage,	16½
Organic nitrogen in fine-ground medium bone and tankage,	15

Trade Values of Fertilizing Ingredients, etc. — Concluded.

	Cents per Pound.
Organic nitrogen in medium bone and tankage,	12
Organic nitrogen in coarse bone and tankage,	7
Organic nitrogen in hair, horn shavings and coarse fish scraps,	7
Phosphoric acid soluble in water,	6
Phosphoric acid soluble in ammonium citrate,	5½
Phosphoric acid in fine bone and tankage,	5½
Phosphoric acid in fine medium bone and tankage,	4½
Phosphoric acid in medium bone and tankage,	3
Phosphoric acid in coarse bone and tankage,	2
Phosphoric acid in fine-ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
Phosphoric acid insoluble (in ammonium citrate) in mixed fertilizers,	2
Potash as high-grade sulphate, and in mixtures free from muriate,	5¼
Potash as muriate,	4½

The manurial constituents contained in feed stuffs are valued as follows: —

	Cents per Pound.
Organic nitrogen,	15
Phosphoric acid,	5
Potash,	5

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones or other equally good forms, and not from leather, shoddy, hair or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1894, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent, in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

- Sulphate of ammonia,
- Nitrate of soda,
- Muriate of potash,
- Sulphate of potash,
- Dried blood,
- Dried ground meat,
- Dry ground fish,
- Azotin,
- Ammonite,
- Castor pomace,
- Bone and tankage,
- Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. THE PROVISIONS OF THE ACT ARE AS FOLLOWS:

[CHAPTER 296.]

AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.

Be it enacted, etc., as follows:

SECTION 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

Sect. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

Sect. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

Sect. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

Sect. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles, nitrogen, phosphoric acid and potassium oxide, guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they

desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates should be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. LIST OF MANUFACTURERS AND DEALERS WHO HAVE SECURED CERTIFICATES FOR THE SALE OF COMMERCIAL FERTILIZERS IN THIS STATE DURING THE PAST YEAR (MAY 1, 1894, TO MAY 1, 1895), AND THE BRANDS LICENSED BY EACH.

Allison, Stroup & Co., New York, N. Y.: —
  Odorless Phosphate.
  Canada Wood Ashes.

Ames Fertilizer Company, Peabody, Mass.: —
  Plymouth Rock Brand.
  Special Potato Fertilizer.
  Strawberry Fertilizer.
  Ground Bone.
  Nitrate of Soda.
  Sulphate of Potash.
  Muriate of Potash.

H. J. Baker & Bro., New York, N. Y.: —
  Special Potato Manure.
  Special Grass Manure.
  "A A" Ammoniated Superphosphate.
  Special Tobacco Manure.
  Special Corn Manure.
  Standard A X C D Fertilizer.
  Special Strawberry Manure.
  Pure Ground Bone.
  Nitrate of Soda.
  Muriate of Potash.

C. A. Bartlett, Worcester, Mass.: —
  Pure Ground Bone.
  Animal Fertilizer.

J. L. Bonzey, Auburn, Mass.: —
  Ground Bone.

Bowker Fertilizer Company, Boston, Mass.: —
  Stockbridge Special Manures.
  Bowker's Hill and Drill Phosphate.
  Bowker's Farm and Garden Phosphate.
  Bowker's Lawn and Garden Dressing.
  Bowker's Fish and Potash.

Bowker Fertilizer Company, Boston, Mass. — *Concluded.*
Bowker's Potato and Vegetable Manure.
Bowker's Sure Crop Bone Phosphate.
Gloucester Fish and Potash.
Bowker's Dried Ground Fish.
Bowker's Fresh Ground Fish.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.

Bradley Fertilizer Company, Boston, Mass. : —
X L Phosphate.
Potato Manure.
B D Sea Fowl Guano.
Complete Manures.
Fish and Potash.
High-grade Tobacco Manure.
English Lawn Fertilizer.
Breck's Lawn and Garden Dressing.
Circle Brand Bone and Potash.
Eclipse Phosphate.
Fine-ground Bone.
Dissolved Bone-black.
Sulphate of Ammonia.
Nitrate of Soda.
Muriate of Potash.
Sulphate of Potash.

W. J. Brightman & Co., Tiverton, R. I. : —
High-grade Potato and Root Manure.
Superphosphate.
Fish and Potash.
Menhaden Fish Guano.

Bryant & Brett, New Bedford, Mass. : —
Ground Bone.

Joseph Church & Co., Tiverton, R. I. : —
Church's Fish and Potash.
Church's " B " Special Fertilizer.
Church's " C " Standard Fertilizer.

Clark's Cove Fertilizer Company, Boston, Mass. : —
- Bay State Fertilizer.
- Bay State Fertilizer, "G G."
- King Philip Guano.
- Potato and Tobacco.
- Great Planet "A."
- Bay State Potato Manure.
- Tobacco Fertilizer.
- Fish and Potash.
- White Oak Pure Ground Bone.
- Muriate of Potash.
- Sulphate of Potash.
- Nitrate of Soda.

Cleveland Dryer Company, Boston, Mass. : —
- Corn and Grain Phosphate.
- Cleveland Fertilizer.
- Cleveland Potato Phosphate.
- Cleveland Superphosphate.

Cleveland Linseed Oil Company, Cleveland, O. : —
- Connecticut Wrapper Fertilizer.
- Coarse Linseed Meal.

E. Frank Coe Company, New York, N. Y. : —
- Alkaline Bone.
- High-grade Ammoniated Bone Superphosphate.
- Red Brand Excelsior.
- Gold Brand Excelsior.
- Special Tobacco Fertilizer.
- High-grade Potato Fertilizer.
- Fish and Potash.
- Special Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —
- Ammoniated Bone Superphosphate.
- Potato, Hop and Tobacco Phosphate.
- Special Potato Manure.
- Pure Ground Bone.
- Ammoniated Practical Superphosphate.
- Vegetable Bone Superphosphate.
- New Rival Ammoniated Superphosphate.
- Ammoniated Wheat and Corn Phosphate.
- Lawn Fertilizer.
- Ground Bone Meal.

Cumberland Bone Phosphate Company, Boston, Mass.: —
- Concentrated Phosphate.
- Cumberland Fertilizer.
- Potato Phosphate.
- Superphosphate.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
- Animal Fertilizer.
- Extra Bone Phosphate.
- Potato and Root Crop Manure.
- Lawn and Garden Manure.
- Tobacco Grower.
- Pure Fine Bone.
- Pure Dissolved Bone.

Davidge Manufacturing Company, New York, N. Y.: —
- Special Favorite.
- Wheat and Corn Phosphate.
- Tobacco Fertilizer.
- Vegetator.

John C. Dow & Co., Boston, Mass.: —
- Dow's Nitrogenous Superphosphate.
- Dow's Ground Bone Fertilizer.
- Dow's Ground Bone.

Forest City Wood Ash Company, Boston, Mass.: —
- Canada Unleached Wood Ashes.

Wm. E. Fyfe & Co., Clinton, Mass.: —
- Wood Ashes (Star Brand).

Great Eastern Fertilizer Company, Rutland, Vt.: —
- Great Eastern General for Grain and Grass.
- Great Eastern Vegetable, Vine and Tobacco.
- Great Eastern General, Oats, Buckwheat and Seeding-down.
- Great Eastern Soluble Bone and Potash Fertilizer.

Hargraves Manufacturing Company, Fall River, Mass.: —
- Ground Bone.

Edmund Hersey, Hingham, Mass.: —
- Fine-ground Bone.

Thos. Hersom & Co., New Bedford, Mass.: —
- Bone Meal.
- Meat and Bone.

John G. Jefferds, Worcester, Mass.: —
  Animal Fertilizer.
  Potato Fertilizer.
  Ground Bone.

Thos. Kirley, South Hadley Falls, Mass.: —
  Pride of the Valley.

A. Lee & Co., Lawrence, Mass.: —
  Lawrence Fertilizer.

Lowe Bros. & Co., Fitchburg, Mass.: —
  Bone.

Lowell Bone Fertilizer Company, Lowell, Mass.: —
  Lowell Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N. Y.: —
  The Mapes Bone Manures.
  Peruvian Guano.
  The Mapes Superphosphates.
  The Mapes Special Crop Manures.
  Sulphates of Potash.
  Economical Manure.
  Nitrate of Soda.

Mason, Chapin & Co., Providence, R. I.: —
  Odorless Chemical Compound Fertilizer.

James E. McGovern, Lawrence, Mass.: —
  West Andover Market Bone Phosphate.
  Ground Bone.

McQuade Bros., West Auburn, Mass.: —
  Ground Bone.

Munroe, Lalor & Co., Oswego, N. Y.: —
  Canada Wood Ashes.
  Swift's Ground Bone.

National Fertilizer Company, Bridgeport, Conn.: —
  Complete Fertilizers.
  Universal Phosphate.
  Fish and Potash.
  Ground Bone.

Pacific Guano Company, Boston, Mass. : —
- Pacific Guano.
- Potato Manure.
- Potato and Tobacco Fertilizer.
- Fish and Potash.
- High-grade General Fertilizer.

John J. Peters, Long Island City, N. Y. : —
- Sheep Fertilizers.

Powers, Gibbs & Co. : —
- Special Potato Guano.
- X X X X X Peerless Ammoniated Guano.
- Sea Bird Ammoniated Guano.

Prentiss, Brooks & Co., Holyoke, Mass. : —
- Complete Manure.
- Phosphate.
- Nitrate of Soda.
- Muriate of Potash.
- Sulphate of Potash.
- Tankage.
- Dissolved Bone-black.

Preston Fertilizer Company, Greenpoint, L. I. : —
- Potato Fertilizer.
- Ammoniated Bone Superphosphate.

Quinnipiac Company, Boston, Mass. : —
- Quinnipiac Phosphate.
- Quinnipiac Potato Manure.
- Quinnipiac Market-garden Manure.
- Quinnipiac Fish and Potash, Crossed Fishes.
- Quinnipiac Fish and Potash, Plain Brand.
- Quinnipiac Potato and Tobacco Fertilizer.
- Quinnipiac Havana Tobacco Fertilizer.
- Quinnipiac Corn Manure.
- Quinnipiac Grass Fertilizer.
- Quinnipiac Bone Meal.
- Quinnipiac Dry Ground Fish.
- Quinnipiac Onion Manure.
- Ammoniated Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.
- Sulphate of Ammonia.

Quinnipiac Company, Boston, Mass. — *Concluded.*
  Nitrate of Soda.
  Dissolved Bone-black.
  Tankage.

Read Fertilizer Company, New York, N. Y.: —
  Read's Standard.
  High-grade Farmer's Friend.
  Fish and Potash.
  Vegetable and Vine.

John S. Reese & Co., Baltimore, Md.: —
  Potato Special.
  New England Favorite.
  Pilgrim.

N. Roy & Son, South Attleborough, Mass.: —
  Animal Fertilizer.

Lucien Sanderson, New Haven, Conn.: —
  Formula "A."
  Formula "B."
  High-grade Sulphate of Potash.
  Regular Sulphate of Potash.

Edward H. Smith, Northborough, Mass.: —
  Fine-ground Bone.

Springfield Provision Company, Brightwood, Mass.: —
  Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass.: —
  Complete Manure.
  Standard Guano.
  Potato and Tobacco Fertilizer.
  Standard Fertilizer.
  Standard Superphosphate.

T. L. Stetson, Randolph, Mass.: —
  Fine-ground Bone.

F. C. Sturtevant, Hartford, Conn.: —
  Tobacco and Sulphur Fertilizer.

Henry F. Tucker, Boston, Mass.: —
  Original Bay State Bone Superphosphate.
  Imperial Bone Superphosphate.
  Special Potato Fertilizer.

Walker, Stratman & Co., Pittsburg, Pa.: —
- Potato Special.
- Tobacco Special.
- Banner.
- Four Fold.

M. E. Wheeler & Co., Rutland, Vt.: —
- Corn Fertilizer.
- Potato Manure.
- Grass and Oats Fertilizer.
- Electrical Dissolved Bone.

Whittemore Bros., Wayland, Mass.: —
- Whittemore's Complete Manure.

Leander Wilcox, Mystic, Conn.: —
- Potato, Onion and Tobacco Manure.
- Ammoniated Bone Superphosphate.
- High-grade Fish and Potash.
- Dry Ground Fish.

Williams & Clark, Boston, Mass.: —
- Potato Phosphate.
- Grass Manure.
- High-grade Special.
- Americus Corn Phosphate.
- Americus Potato and Tobacco Manure.
- Universal Ammoniated Dissolved Bones.
- Prolific Crop Producer.
- Americus Fish and Potash.
- Fish and Potash, No. 1.
- Royal Bone Phosphate.
- Onion Manure.
- Americus Ammoniated Bone Superphosphate.
- Dry Ground Fish.
- Pure Bone Meal.
- Tobacco Fertilizer.
- Tankage.
- Muriate of Potash.
- Sulphate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Double Sulphate of Potash.

4. Analyses of Licensed Fertilizers collected during 1894 in the General Markets by the Agent of the Massachusetts State Agricultural Experiment Station.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
7	Lowell Bone Fertilizer,	J. W. Butman, Lowell, Mass.,	Amherst.
15	Blood, Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
17	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
22	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
27	Complete Manure for Corn and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
29	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
30	Complete Manure for General Use,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
31	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Worcester.
32	Potato Manure,	J. G. Jefferds, Worcester, Mass.,	Worcester.
35	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
40	X L Superphosphate,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
41	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
42	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
43	Crossed Fish and Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
53	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.

55	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Sunderland.
60	High-grade Special,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
62	Complete Tobacco Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
63	Chittenden's Fish and Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
67	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
68	Complete Corn Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
69	Ground Tankage,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
73	Complete Grass Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
76	Superphosphate,	Prentiss, Brooks & Co , Holyoke, Mass.,	Holyoke.
79	Blood, Meat and Bone,	Springfield Provision Company, Brightwood, Mass.,	Brightwood.
99	Fish and Potash,	Wm. J. Brightman & Co., Tiverton, R. I.,	Dighton.
120	Complete Manure for Corn and Grass,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
127	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
141	Potato Special,	H. F. Tucker, Boston, Mass.,	Taunton.
149	Complete Tobacco Manure,	National Fertilizer Company, Bridgeport, Conn.,	Deerfield.
166	Tobacco Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
7	Lowell Bone Fertilizer,	10.32	2.55	2	-	7.84	.67	8.51	8	7.84	-	2.94	2
15	Blood, Bone and Meat,	11.36	8.25	6.59—8.24	.08	6.08	2.92	9.08	10—12	6.16	-	-	-
17	Blood, Bone and Meat,	6.49	4.94	5.77—7.41	.38	11.44	5.40	17.22	10—12	11.82	-	-	-
22 41	Corn Manure,	15.65	2.42	2.06—2.88	6.24	4.87	1.79	12.90	10—14	11.11	9—12	3.18	1.50—2.50*
27 120	Complete Manure for Corn and Grain,	9.38	3.81	3.30—4.12	3.04	8.16	4.81	16.01	13—15	11.20	12—14	2.98	3—4*
29	Potato Manure,	7.99	3.60	3.71—4.12	4.91	4.91	.67	10.49	8—10	9.82	8	8.20	6—8*
30	Complete Manure for General Use,	11.71	3.33	3.30—4.12	4.98	4.41	.90	10.29	10—12	9.39	-	5.40	4—5
31 127	Animal Fertilizer,	6.08	2.78	3.30—4.12	3.74	8.52	1.66	13.92	13—15	12.26	-	8.26	7—8
32	Potato Manure,	9.35	2.28	2.47—3.30	4.72	6.54	2.82	14.08	15—17	11.26	10—12	5.48	5—6
35	Potato Manure,	12.82	2.82	2.5—3.25	2.81	4.00	2.20	9.01	8—11	6.81	6—8	5.12	5—6
40	X L Superphosphate,	14.23	2.77	2.50—3.25	6.52	2.76	1.80	11.08	11—14	9.28	9—11	2.08	2—3*

42	Potato Manure,	13.10	2.50	2.47—3.30	3.33	5.21	.77	9.31	7—11	8.54	6—9	7.26	5—6*
43	Crossed Fish and Potash,	16.10	3.92	3.30—4.12	4.61	1.14	1.41	7.16	5—8	5.75	3—5	5.08	3—5*
53 67	Dry Ground Fish,	11.49	7.58	7.41—9.06	.74	5.78	1.51	8.03	7—9	6.52	-	-	-
55	Vegetable, Vine and Tobacco Fertilizer,	14.70	2.32	2.06—2.51	6.98	1.01	1.46	9.45	9—15	7.99	8—12	6.35	6—8
60	High grade Special,	12.41	3.95	3.7—4.12	5.23	2.86	1.20	9.29	8—11	8.09	7—9	7.43	7—9
62 149	Complete Tobacco Manure,	10.28	3.41	3.30—4.94	6.19	5.37	1.23	12.79	10—12	11.56	8—10	5.48	5.40—6.48
63	Chittenden's Fish and Potash,	8.73	2.92	2.88—3.71	3.79	3.83	1.69	9.31	6—8	7.62	-	4.45	5—6
68	Complete Corn Manure,	10.52	3.24	3.30—4.12	5.17	2.71	3.94	11.82	8—10	7.88	6—8	7.33	6—8
69	Ground Tankage,	8.91	7.73	7.41—7.83	.65	5.74	1.16	7.55	8—9	6.39	-	-	-
73	Complete Grass Manure,	5.93	4.89	4.12—4.94	2.20	2.86	3.84	8.90	7—8	5.06	4—5	8.42	7—9
76	Superphosphate,	12.60	2.74	2.06—2.47	9.52	.86	3.74	14.12	10—12	10.38	8—10	2.81	2.5—3
79	Blood, Meat and Bone,	8.08	8.13	7—8	.35	5.98	1.36	7.69	9.5—10.5	6.33	-	-	-
99	Fish and Potash,	18.10	2.91	2.07—2.88	3.48	3.53	1.18	8.19	7.5—10.5	7.01	6—8	2.45	2—3
141	Potato Special,	10.27	2.78	2.40	6.75	1.80	1.79	10.34	9—13	8.55	8—11	5.40	6—7
166	Tobacco Fertilizer,	12.25	1.70	3.30—4.12	10.36	1.66	1.54	13.56	-	12.02	9—10	1.24	3.79—5.05

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
152	Fish and Potash,	Clark Cove Fertilizer Company, Boston, Mass ,	Deerfield.
170	Standard Unexcelled Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
172	Ammoniated Bone Superphosphate,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
176	High-grade Fish Guano and Potash,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
179	Potato, Hop and Tobacco Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
182	Bay State Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Greenfield.
187	Tobacco Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Greenfield.
202	Animal Fertilizer,	N. Roy & Son, North Attleborough, Mass.,	Amherst.
266	Tobacco Grower,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Sunderland.
	Chemicals.		
12	Electrical Dissolved Bone,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
14	Dissolved Bone-black,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
18	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
19	Dissolved Bone-black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
21	Sulphate of Potash and Magnesia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
36	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
46	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.

47	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
58	Muriate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
61	Sulphate of Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
66	Sulphate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
70	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
92	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
145	Sulphate of Potash and Magnesia,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
146	Dissolved Bone-black,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
208	Muriate of Potash,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
	Bones.		
6	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Amherst.
8	Fine-ground Bone,	McQuade Bros., West Auburn, Mass ,	Amherst.
28	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Worcester.
77	Fine-ground Bone,	McQuade Bros., West Auburn, Mass.,	West Auburn.
90	Ground Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.
214	Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
152	Fish and Potash, ...	15.00	2.81	2.06—2.88	4.35	2.66	1.38	8.39	7—11	7.01	6—8	2.43	2—3
170	Standard Unexcelled Fertilizer, ...	13.93	2.72	2.06—2.26	8.14	.53	1.05	9.72	-	8.67	8—10	2.82	2—3
172	Ammoniated Bone Superphosphate, . . .	10.05	2.73	2	7.01	2.82	3.17	13.00	11—15	9.83	9—12	2.67	1.85
176	High-grade Fish Guano and Potash, . . .	7.15	2.63	2.47—3.30	2.56	2.45	3.48	8.49	7—11	5.01	6—9	3.39	2.75*
179	Potato, Hop and Tobacco Fertilizer, . . .	14.03	2.07	2—3	7.01	3.30	1.33	11.64	11—14	10.31	10—12	3.84	3.25—4.30
182	Bay State Fertilizer, ...	12.83	2.60	2.47—3.30	5.35	3.18	1.91	10.44	10—14	8.53	9—12	2.80	2—3
187	Tobacco Manure, ...	6.09	5.62	6.18	-	5.40	.15	5.55	4—5	5.40	-	12.34	10.5
202	Animal Fertilizer, ...	4.07	4.28	4.28	.13	11.54	.28	11.95	11.95	11.67	-	-	-
266	Tobacco Grower, ...	8.89	4.22	4.94—5.77	.97	4.71	1.33	7.01	10—12	5.68	-	9.73	10.80
	Chemicals.												
12	Electrical Dissolved Bone, ...	13.95	-	-	7.82	5.06	.58	13.46	15—20	12.88	13—17	-	-
14	Dissolved Bone-black, ...	12.63	-	-	12.84	2.51	.77	16.12	16—18	15.35	-	-	-
18 36	Sulphate of Potash and Magnesia, ...	3.54	-	-	-	-	-	-	-	-	-	27.16	27.02—29.72
19	Dissolved Bone-black, ...	13.36	-	-	16.88	-	-	16.88	16—18	16.88	16.18	-	-

21	Sulphate of Potash and Magnesia,	3.95	-	-	-	-	-	-	-	-	-	29.44	27.02—29.72		
46	Sulphate of Ammonia,	.73	20.55	19.78—20.60	-	-	-	-	-	-	-	-	-		
47 92	Nitrate of Soda,	1.00	15.79	15.64—15.97	-	-	-	-	-	-	-	-	-		
58	Muriate of Potash,	1.34	-	-	-	-	-	-	-	-	-	50.44	50.54—53.70		
61	Sulphate of Potash,	1.10	-	-	-	-	-	-	-	-	-	49.92	-		
66	Sulphate of Potash,	.75	-	-	-	-	-	-	-	-	-	48.16	48.64—51.34		
70	Dissolved Bone-black,	12.16	-	-	15.51	-	2.00	17.50	16—17	15.51	16	-	-		
145	Sulphate of Potash and Magnesia,	5.89	-	-	-	-	-	-	-	-	-	25.80	25.94—28.10		
146	Dissolved Bone-black,	15.97	-	-	15.81	.44	.36	16.61	-	16.25	15—16	-	-		
208	Muriate of Potash,	1.42	-	-	-	-	-	-	-	-	-	50.04	50.54—53.70		
												MECHANICAL ANALYSIS.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
6 28	Steamed Fine Bone,	4.91	4.09	4.02	.30	18.63	2.93	21.86	23	18.93	7.69	23.80	47.32	28.88	-
8 77	Fine-ground Bone,	3.29	2.73	2.78	.05	22.82	1.64	24.51	24.52	22.87	16.74	47.07	23.63	18.00	11.30
90	Ground Bone,	2.14	1.65	1.65—2.47	.20	25.84	2.05	28.09	24—26	26.04	-	60.67	39.33	-	-
214	Ground Bone,	6.08	3.98	2.90—3.70	.26	16.32	8.67	25.25	25	16.58	-	43.87	25.66	22.60	7.87

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* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
3	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
9	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
20	Pulverized Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
37	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
38	Quinnipiac Phosphate,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
65	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
81	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
82	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
85	Potato and Vegetable,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
89	Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Amherst.
93	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
94	Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	Boston.
95	Special Potato Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
97	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Somerset.
98	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
104	Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Bridgewater.
105	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Whitman.

106	Vegetable, Vine and Fruit,	Read Fertilizer Company, Syracuse, N. Y.,	Bridgewater.
110	Pure Dry Ground Fish,	Joseph Church & Co., Tiverton, R. I.,	Dighton.
111	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Whitman.
113	Fish and Potash, "B Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Bridgewater.
114	Brightman's Phosphate,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
161	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
164	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
190	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
261	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
	Chemicals.		
45	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
56	Dissolved Bone-black,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
107	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
108	Nitrate of Soda,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
201	Dissolved Bone-black,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
220	Dissolved Bone-black,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
3 261	Banner Fertilizer,	9.62	2.65	2.06—2.88	5.32	2.13	2.00	9.45	11—12	7.45	9—10	1.62	1—2*
9 93	Corn Fertilizer,	13.65	2.88	1.65—2.47	4.64	3.22	1.64	9.50	9—14	7.86	8—12	2.45	1.65—2.47*
20	Pulverized Bone and Meat,	7.29	5.21	5.77—6.59	.30	11.99	5.58	17.87	18—20	12.29	-	-	-
37 190	Ammoniated Bone Superphosphate, "Americus,"	13.88	2.63	2.47—3.30	6.26	2.82	2.18	11.26	10—13	9.08	9—11	2.70	2—3
38	Quinnipiac Phosphate,	15.13	2.92	2.47—3.30	6.00	3.47	.84	10.31	10—14	9.47	9—12	2.73	2—3*
65	Ammoniated Bone Superphosphate,	14.82	2.48	1.65—2.06	.82	7.60	2.51	10.93	9—11	8.42	7—9	3.25	2—4
81	Hill and Drill Phosphate,	13.53	2.80	2.50—3.50	5.22	4.04	3.28	12.54	12—13	9.26	9—11	2.35	2—3
82	Lawn and Garden Dressing,	9.32	4.86	3.25—4.25	5.63	1.95	3.17	10.75	8—10	7.58	6—8	5.54	5—6
85	Potato and Vegetable,	12.20	3.28	3.25—4.25	6.14	2.82	1.89	10.85	8—10	8.96	6—8	6.92	7—8
89	Ground Bone Fertilizer,	6.66	2.20	2.06—2.47	.87	14.74	4.50	20.11	18—22	15.61	-	3.51	1.62—1.89
94	Wood Ashes,	11.59	-	-	-	-	-	1.13	1.5—2.5	-	-	5.28	4.5—8
95	Special Potato Fertilizer,	9.73	3.00	3—4	4.61	5.13	.79	10.53	9—13	9.74	8—11	9.00	7—9

97	Potato and Root Crop Manure,	9.43	2.76	2.88—4.12	3.48	6.24	1.74	11.46	10—12	9.72	6—8	6.57	7—9
98	Potato Manure,	10.99	4.01	3.30	4.52	1.77	.54	6.83	5.75	6.29	-	10.64	10
104	Animal Fertilizer,	13.21	3.06	3—4.5	3.89	4.25	.92	9.06	10—12	8.14	6—8	3.58	4—6
105	Standard Fertilizer,	15.07	2.20	2—3	5.76	2.56	2.30	10.62	10—15	8.32	8—12	2.18	2—3
106	Vegetable, Vine and Fruit,	12.01	1.84	1.65—2.47	4.55	3.13	.46	8.14	7—9	7.68	6—8	7.54	8—10
110	Pure Dry Ground Fish,	7.89	9.62	9.06—9.89	.10	6.70	1.69	8.49	6.87—9.16	6.80	-	-	-
111	English Lawn Dressing,	9.75	3.87	4.95—5.78	1.28	5.42	1.33	8.03	6—8	6.70	5—7	2.08	2.5—3.5
113	Fish and Potash, "B Brand,"	17.80	2.58	2.06—2.88	4.35	1.12	2.46	7.93	7.5—10.5	5.47	6—8	2.70	2—3
114	Brightman's Phosphate,	12.75	2.50	2.5—3.25	3.99	3.02	.67	7.68	8—11	6.01	6—8	5.72	5—6
161 164	Potato Fertilizer,	15.08	1.10	3.30—4.12	5.73	4.14	1.13	11.00	-	9.87	8—9	7.46	7—9
	Chemicals.												
45 107	Dissolved Bone-black,	13.75	-	-	14.67	.45	.33	15.45	18	15.12	15—18	-	-
56	Dissolved Bone-black,	12.52	-	-	12.13	3.12	.26	15.51	15—18	15.25	-	-	-
108	Nitrate of Soda,	1.50	15.02	15.5—16.5	-	-	-	-	-	-	-	-	-
201	Dissolved Bone-black,	10.99	-	-	11.90	3.86	.26	16.02	15—18	15.76	-	-	-
220	Dissolved Bone-black,	13.34	-	-	13.15	2.48	.64	16.27	15—18	15.63	-	-	-

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* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
140	Cleveland Superphosphate,	Cleveland Dryer Company, Boston, Mass.,	SouthFramingham.
151	Dry Ground Fish,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
155	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Pittsfield.
160	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
165	Fine-ground Bone and Potash, "Circle Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Pittsfield.
171	Special Potato Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
174	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
178	High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
181	Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
186	Complete Tobacco Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
198	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Hudson.
206	Potato Manure,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
211	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
215	Special Potato Manure,	Pacific Guano Company, Boston, Mass.,	Newburyport.
226	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Lawrence.
229	Alkaline Bone Phosphate,	E. Frank Coe, New York, N. Y.,	Framingham.
238	Blood, Bone and Meat,	Williams & Clark Fertilizer Company, Boston, Mass.,	Dalton.

258	Grass and Grain Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Westfield.
263	Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
	Bones.		
1	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Amherst.
78	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Auburn.
83	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
100	Pure Bone Meal,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
121	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Boston.
124	Fine-ground Bone,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
131	Fine-ground Bone,	Hargraves Manufacturing Company, Fall River, Mass.,	Fall River.
189	Pure Bone Meal,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
233	Pure Ground Bone,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
239	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Amherst.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
140	Cleveland Superphosphate,	14.13	3.46	2.05—2.95	4.61	4.75	2.10	11.46	11—14	9.36	9—11	2.06	2—3
151	Dry Ground Fish,	9.69	8.01	7.41—9.06	.87	4.24	1.59	6.70	7—9	5.11	-	-	-
155 174	Ammoniated Bone Superphosphate,	9.67	2.50	2.47—3.30	6.38	6.40	1.26	14.04	-	12.78	9—11	2.93	2—3
160	Ammoniated Bone Superphosphate,	10.21	3.40	2.90—3.70	7.50	2.68	.73	10.91	11—14	10.18	10—12	1.82	1—2
165	Fine-ground Bone and Potash, "Circle Brand,"	11.15	2.26	1.85—2.68	1.56	7.06	3.10	11.72	8—12	8.62	-	2.42	2—3
171	Special Potato Manure,	13.01	3.79	3.70—4.50	6.40	2.30	.46	9.16	9—11	8.70	8—9	5.67	5.40—6.40
178	High-grade Tobacco Manure,	6.26	6.04	5.77—6.59	.61	3.18	1.28	5.07	4—5	3.79	-	12.75	10.81—12.43*
181	Potato Phosphate,	17.92	2.78	2.47—3.30	4.25	2.50	1.28	8.03	7—11	6.75	6—9	4.60	5—6*
186	Complete Tobacco Manure,	7.59	4.88	4.53—5.36	4.09	.21	.87	5.17	-	4.30	3—5	10.65	10—12
198 226	Cumberland Superphosphate,	14.35	2.28	2.06—2.88	5.76	2.88	2.68	11.32	10—12	8.64	8—10	2.40	2—3*
206	Potato Manure,	10.48	2.44	2.47-3.30	3.48	3.33	2.15	8.96	7—11	6.81	6—9	4.79	5—6*
211	Vegetable Bone Superphosphate,	13.55	5.06	5—6	5.12	1.07	.82	7.01	7—9	6.19	6—7	6.34	6—8*

215	Special Potato Manure,	12.12	2.80	2.47—3.30	2.61	3.33	1.94	7.88	7—10	5.94	5 -7	5.52		5—6*	
229	Alkaline Bone Phosphate,	9.70	1.50	1—1.5	6.40	1.37	3.74	11.51	10—14	7.77	9—12	2.69		1.62—2.16*	
238	Blood, Bone and Meat,	7.13	8.31	-	.46	7.42	2.87	10.75	-	7.88	-	-		-	
258	Grass and Grain Fertilizer,	14.94	2.46	2.88—3.71	6.29	1.74	1.18	9.21	9—15	8.03	8—12	3.49		2—4	
263	Fish and Potash,	14.37	3.48	3.25—4.25	2.66	3.94	.72	7.32	6—7	6.60	5—6	5.23		4—5	
												MECHANICAL ANALYSIS.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
1 121	Pure Bone Meal,	8.70	3.96	3—4	.38	9.48	12.02	21.88	20—26	9.86	-	14.95	25.30	35.96	23.79
78 239	Ground Bone,	8.43	3.87	3.87	.30	16.74	3.68	20.72	20.72	17.04	-	42.30	37.60	15.00	5.10
83	Fresh Ground Bone,	8.94	2.88	2.47—3.30	.31	17.45	3.48	21.24	18—22	17.76	5 -7	21.20	38.10	40.70	-
100	Pure Bone Meal,	4.95	1.88	2	.12	25.08	5.12	30.32	29.21	25.20	-	74.83	15.49	6.68	3.00
124	Fine-ground Bone,	7.10	3.60	2.5—3.25	.05	17.81	1.33	19.19	21—23	17.86	-	51.50	36.80	17.70	-
131	Fine-ground Bone,	7.71	3.48	2.5—2.8	.41	21.34	1.33	23.08	25—27	21.75	-	29.20	22.20	17.40	31.20
189	Pure Bone Meal,	4.62	2.65	2.47—4.12	.31	12.34	6.01	18.66	20 —25	12.65	-	54.80	33.80	11.40	-
233	Pure Ground Bone,	7.67	4.80	2.88—3.71	-	14.34	8.44	22.78	24—26	14.34	-	17.64	25.90	25.12	31.34

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
2	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
10	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
39	Market Garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
51	Odorless Phosphate,	Allison, Stroup & Co., Boston, Mass.,	Amherst.
84	Complete Top-dressing Manure,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
86	Fish and Potash, "D Brand,"	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
87	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
96	Strawberry Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
102	Bristol Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
103	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
109	Farm and Garden Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
112	Standard Fertilizer,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
115	Potato and Root Fertilizer,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
116	High-grade Farmers' Friend,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
117	Lawn and Garden Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
119	Sheep Fertilizer,	John J. Peters, Long Island City, N. Y.,	Boston.
123	Wood Ashes,	Allison, Stroup & Co., Boston, Mass.,	Boston.

129	A A Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
133	Fish and Potash, "D Brand,"	Daniel T. Church & Co., Providence, R. I.,	Dighton.
137	Meat and Bone,	Thomas Hersom & Co, New Bedford, Mass.,	New Bedford.
138	Potato and Root Fertilizer,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
139	Potato Phosphate,	Cleveland Dryer Company, Boston, Mass.,	South Framingham.
142	Bay State Bone Superphosphate,	H. F. Tucker, Boston, Mass.,	Taunton.
143	Plymouth Rock Brand,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
147	Ammoniated Dissolved Bone,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
148	Grass and Grain Fertilizer,	E. Frank Coe, New York, N. Y.,	Williamstown.
156	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
158	Potato Manure,	E. Frank Coe, New York, N. Y.,	Lee.
167	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.
250	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
2 250	Potato Special,	12.01	1.54	2.47—3.30	6.45	2.20	1.94	10.59	12—13	8.65	10—11	6.12	5—6
10 103	Potato Manure,	12.80	2.12	2.06—2.88	5.07	3.27	1.38	9.72	9—15	8.34	8—12	6.46	3.75—4.50
39	Market-garden Manure,	11.46	3.78	3.30—4.12	3.74	5.83	1.02	10.59	9—13	9.57	8—11	7.02	7—8
51	Odorless Phosphate,	.39	-	-	-	-	-	20.84	18	-	-	-	-
64	Complete Top-dressing Manure,	6.40	5.04	5—6	2.05	5.01	2.92	9.98	6—7	7.06	4—6	7.19	6—7
86	Fish and Potash, "D Brand,"	6.95	3.14	2.14—3.14	2.15	3.88	5.48	11.51	8—10	6.03	-	4.09	2—3
87 167	Special Favorite,	6.57	1.50	1.24—2.06	5.88	6.25	2.97	15.10	11—14	12.13	10—12	1.63	1.5—2.5*
96	Strawberry Manure,	12.25	2.77	2.88	2.89	4.13	1.30	8.32	6	7.02	-	9.04	8
102	Bristol Fish and Potash,	15.72	2.04	1.6—2.5	2.58	5.31	3.79	11.68	8—10	7.89	5—8	1.94	2—3
109	Farm and Garden Phosphate,	11.98	2.14	1.5—2.5	2.61	5.59	2.70	10.90	10—14	8.20	8—11	2.13	2—3
112	Standard Fertilizer,	14.12	1.17	.8	6.09	2.25	.72	9.06	9—12	8.34	8	4.36	4—6

115 138	Potato and Root Fertilizer,	10.71	3.72	3.73—4.52	4.30	4.68	1.82	10.80	9—12	8.98	8—11	5.83	6—7
116	High-grade Farmers' Friend,	11.20	3.34	3.30—4.12	4.61	1.54	1.07	7.22	6	6.15	5—6	10.86	10—11
117	Lawn and Garden Dressing,	7.22	3.30	4.12—4.94	1.82	4.27	1.59	7.68	-	6.09	5—6	5.54	5—6
119	Sheep Fertilizer,	13.44	2.14	1.65	-	-	-	1.69	1.20	-	-	1.64	1.70
123	Wood Ashes,	19.62	-	-	-	-	-	1.74	1.36—1.83	-	-	4.70	5.84—6.80
129	A A Ammoniated Superphosphate,	12.77	3.15	2.47—3.30	5.25	5.22	2.02	12.49	-	10.47	10—12	2.32	2—3
133	Fish and Potash, "D Brand,"	19.94	2.53	2.07—2.90	3.63	3.43	.92	7.98	7.50—10.50	7.06	6—8	2.48	2—3
137	Meat and Bone,	5.73	5.53	4.24	.72	10.36	7.96	19.04	19—25	11.08	-	-	-
139	Potato Phosphate,	13.83	1.96	2.05—2.85	3.17	8.48	1.61	11.26	10—13	9.65	8—10	3.56	3—4*
142	Bay State Bone Superphosphate,	11.85	2.02	2	6.04	2.98	2.70	11.72	11—15	9.02	9—12	2.08	1.85
143	Plymouth Rock Brand,	12.55	3.29	3.30—4.12	4.50	5.91	1.74	12.15	9—13	10.41	8—11	4.59	4—4.5
147	Ammoniated Dissolved Bone,	13.01	1.66	1.65—2.47	4.91	4.92	1.48	11.31	10—13	9.83	9—11	2.18	2—3
148	Grass and Grain Fertilizer,	12.12	1.30	.80—1.65	4.61	7.50	.84	13.05	10—13	12.11	9—11	1.66	1.35—1.90
156	Dry Fish Guano,	12.13	8.50	7.41—9.06	.87	4.30	.77	5.94	7—9	5.17	-	-	-
158	Potato Manure,	14.39	2.24	2—2.50	6.47	2.13	3.07	11.67	10—14	8.60	8—11	5.72	6—7

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
168	Potato and Root Crop Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Westfield.
169	Excelsior Tobacco Grower,	E. Frank Coe, New York, N. Y.,	Westfield.
173	Fish and Potash, "Plain Brand,"	Quinnipiac Fertilizer Company, Boston, Mass.,	Westfield.
175	Ground Bone and Potash,	E. Frank Coe, New York, N. Y.,	Lee.
177	Dry Ground Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
184	Potato, Onion and Tobacco Grower,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
185	Fish and Potash, "Americus Brand,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
194	West Andover Market Bone Phosphate,	James E. McGovern, West Andover, Mass.,	Lawrence.
195	Tobacco and Sulphur,	F. C. Sturtevant, Hartford, Conn.,	Fitchburg.
205	King Philip Guano,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
218	Tankage and Bone,	Lowe Brothers & Co., Fitchburg, Mass.,	Fitchburg.
222	Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
228	Eclipse Phosphate,	Bradley Fertilizer Company, Boston, Mass.,	Newburyport.
230	Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
234	Potato and Tobacco Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
235	Soluble Pacific Guano,	Pacific Guano Company, Boston, Mass.,	Newburyport.
237	West Andover Market Bone Phosphate,	James E. McGovern, Lawrence, Mass.,	Amherst.

241	Potato, Onion and Tobacco Fertilizer,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
246	Potato and Tobacco Manure,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
247	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	South Hadley Falls.
267	Oats, Buckwheat and Seeding-down,	Great Eastern Fertilizer Company, Rutland, Vt.,	Orange.
270	Havana Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
272	Fish and Potash,	Pacific Guano Company, Boston, Mass.,	Belchertown.
274	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	Amherst.
	Bones.		
33	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
34	Pure Fine-ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
125	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
196	Pure Fine-ground Bone,	J. G Jefferds, Worcester, Mass.,	Hudson.
199	Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
221	Ground Bone,	James E. McGovern, West Andover, Mass.,	Lawrence.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
168	Potash and Root Crop Manure,	7.88	4.35	4.12—4.94	5.07	3.38	1.43	9.88	7—9	8.45	5—6	7.45	7—9*
169	Excelsior Tobacco Grower,	9.35	4.10	3—4	6.70	2.18	3.07	11.95	8—11	8.88	8—11	5.64	5—6*
173	Fish and Potash, "Plain Brand,"	17.83	2.50	2.06—2.88	3.89	1.44	.61	5.94	6—9	5.33	4—6	4.04	4—6
175	Ground Bone and Potash,	4.23	1.27	-	.33	9.99	4.82	14.14	-	10.32	-	12.48	-
177	Dry Ground Fish,	13.92	7.70	8—10	1.36	3.22	2.56	7.14	7—8	4.58	-	-	-
184	Potato, Onion and Tobacco Grower,	9.62	3.62	3.71—4.12	2.71	6.19	1.28	10.18	8—11	8.90	7—9	7.44	7—9
185	Fish and Potash, "Americus Brand,"	16.68	2.35	2.06—2.88	4.09	2.82	1.07	7.98	6—9	6.91	4—6	2.48	4—6
194 237	West Andover Market Bone Phosphate,	12.58	1.56	2—3	4.02	9.62	.36	14.02	13—15	13.64	-	1.96	3—4
195	Tobacco and Sulphur,	13.08	2.20	1.96	-	-	-	.87	.75	-	-	7.67	7.66
205	King Philip Guano,	16.67	1.16	.91—1.65	5.94	3.53	.92	10.39	9—12	9.47	8—10	2.21	2—3
218	Tankage and Bone,	4.26	2.84	-	-	-	-	24.38	-	-	-	-	-
222	Royal Bone Phosphate,	17.38	1.45	1—1.64	3.89	6.09	1.15	11.13	8—12	9.98	7—10	2.66	2—3
228	Eclipse Phosphate,	13.93	1.20	1—2	4.71	4.50	2.30	11.51	10—14	9.21	8—11	1.82	1.5—2.5

230	Lawrence Fertilizer, ...	13.54	1.62	2.06—2.88	2.81	6.24	2.23	11.28	10—12	9.05	-	2.10		2—3	
234	Potato and Tobacco Fertilizer, ...	11.60	1.92	2.06—2.80	2.66	6.90	1.54	11.00	9—14	9.46	8—11	2.91		3—4*	
235	Soluble Pacific Guano, ...	13.06	2.06	2.25—3.00	6.88	2.70	.82	10.44	10.50—16	9.53	8.50—11	2.23		2—3.50	
241	Potato, Onion and Tobacco Fertilizer, . .	14.42	3.39	3.25—4.25	4.76	3.66	1.07	9.49	8—9	8.42	6—8	6.17		6—7	
246	Potato and Tobacco Manure, ...	12.51	2.94	2.06—2.88	4.20	5.21	2.00	11.41	9—13	9.41	8—11	3.08		3—4*	
247 274	Pride of the Valley, ...	13.81	1.54	2.06—2.88	.82	6.34	.49	7.65	7—9	7.16	-	3.16		2.70—3.78*	
267	Oats, Buckwheat and Seeding down, . .	13.79	1.14	.82—1.65	.77	7.39	.90	9.06	9—15	8.16	8—12	5.04		4—6	
270	Havana Tobacco Fertilizer, ...	10.15	6.38	6.77—6.59	1.38	1.59	.97	3.94	6—9	2.97	5—7	10.88		10—12	
272	Fish and Potash, ...	18.67	3.48	2.06—2.88	3.04	2.82	.69	6.55	6—10	5.86	4—7	3.77		4—6	
												Mechanical Analysis.			
	Bones.											Fine.	Med. Fine.	Med	Coarse Med
83 125	Pure Ground Bone, ...	4.12	2.85	2—3	.49	18.88	7.80	27.17	27—29	19.37	-	57.08	28.60	13.77	.54
84 196	Pure Fine ground Bone, ...	3.04	1.36	2.47—4.12	–	25.84	3.17	29.01	25—30	25.84	-	75.06	22.94	2.00	-
199	Bone Meal, ...	6.25	3.80	2—3	.03	16.29	7.60	23.92	26—28	16.32	-	38.35	29.25	21.02	10.48
221	Ground Bone, ...	8.87	1.80	-	.03	16.61	2.94	19.58	–	16.64	-	51.88	18.94	12.80	16.38

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
4	Tobacco Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
5	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
11	Grass and Oats Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
16	Pulverized Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
26	Animal Fertilizer,	J. G. Jefferds, Worcester, Mass.,	Worcester.
64	Dry Ground Fish Guano,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
88	Vegetator,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
91	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Amherst.
101	Harvest Home Phosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
126	Strawberry Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
130	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Dighton.
132	Manhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
134	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
135	Economical Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
136	Church's B Special Fertilizer,	Daniel T. Church & Co , Providence, R. I.,	Dighton.
154	Sheep Fertilizer,	Wm. Elliott & Sons, New York, N. Y.,	Pittsfield.
162	Wheat and Corn Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

163	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
183	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Greenfield.
188	Sure Crop Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Shelburne Falls.
192	Grass Manure,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
193	Grass Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
200	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
203	Gold Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Framingham.
204	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Hudson.
209	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
219	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
227	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Lowell.
252	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
257	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Westfield.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	Tobacco Special,	8.79	2.37	2.47—3.30	6.75	3.23	.97	10.95	10—12	9.98	8—10	4.00	3.24—4.32*
5 252	Four Fold,	9.95	1.80	1.65—2.47	5.99	3.68	1.64	11.31	10—11	9.67	8—9	1.66	2—3*
11	Grass and Oats Fertilizer,	15.42	-	-	6.26	3.18	.16	9.60	12—18	9.44	10—14	2.33	2—4*
16	Pulverized Bone and Meat,	6.17	5.60	4.94—5.77	.26	7.72	9.98	17.96	18—20	7.98	-	-	-
26	Animal Fertilizer,	10.51	2.50	2.47—3.30	4.76	6.21	6.35	17.32	16—18	10.97	11—13	2.58	2.5—3.5
64	Dry Ground Fish Guano,	9.64	7.41	-	.64	5.70	.72	7.06	-	6.34	-	-	-
88	Vegetator,	12.37	2.10	2.06—3.71	9.22	1.86	1.28	12.36	-	11.08	5—7	1.92	3—5
91 130	Nitrogenous Superphosphate,	16.10	2.10	2.06—2.88	2.97	7.63	1.94	12.54	8—10	10.60	-	4.37	1.89—2.53
101	Harvest Home Phosphate,	12.21	1.46	1.03—1.65	1.64	7.63	1.07	10.34	-	9.27	8—10	3.36	2—2.5
126	Strawberry Fertilizer,	13.00	2.70	2.47—3.30	4.73	3.97	3.15	11.85	10—12	8.70	9—11	6.42	6—7
132	Menhaden Fish Guano,	9.81	8.20	8.24—9.89	1.05	3.54	2.46	7.05	6.87—9.16	4.59	-	-	-
134	Potato Manure,	6.23	3.80	3.71—4.12	2.12	3.74	2.38	8.24	8—10	5.86	8	8.36	6—8*

135	Economical Manure, ...	11.42	2.78	2.47—3.30	4.25	3.93	.31	8.49	8—10	8.18	6—8	9.86	8—10
136	Church's B Special Fertilizer, ...	11.48	3.40	3.73—4.52	1.84	6.30	2.71	10.85	9—13	8.14	8—11	6.16	6—7
154	Sheep Fertilizer, ...	9.40	1.91	-	-	-	-	2.18	-	-	-	3.02	-
162	Wheat and Corn Fertilizer, ...	11.52	1.01	.82—1.65	10.50	2.34	1.66	14.50	8—12	12.84	7—9	1.24	1—2
163 183	Ammoniated Wheat and Corn Phosphate, .	12.64	2.26	2—3	6.70	3.54	1.79	12.03	-	10.24	10—13	1.35	1.60—2.70
188	Sure Crop Phosphate, ...	11.75	.90	.75—1.50	4.35	4.96	3.28	12.59	-	9.31	8—10	1.17	1—2
192	Grass Manure, ...	11.23	3.44	3.91—4.74	2.25	3.43	1.07	6.75	6—8	5.68	5—7	2.39	2—3
193	Grass Fertilizer, ...	10.36	3.10	3.91—4.74	2.48	4.12	1.18	7.78	6—8	6.60	5—7	2.33	2—3
200 219	Superphosphate, ...	16.10	1.75	1.97	1.07	6.70	.72	8.49	-	7.77	10.17	1.28	2.36
203	Gold Brand Excelsior Guano, ...	7.70	2.60	2.5—3	6.70	2.41	1.94	11.05	9—13	9.11	8—11	6.25	6—8
204 227	Potato Fertilizer, ...	15.52	1.91	2.06—2.88	6.04	3.25	1.30	10.59	11—13	9.29	9—11	3.40	3—4
209 257	Great Planet "A,"	10.44	3.16	3.30—4.12	2.56	7.06	2.35	11.97	9—13.50	9.62	8—11.50	7.21	7—8

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* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
210	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
213	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
217	Lawn Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
223	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
236	Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
248	Standard Superphosphate,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
251	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.
253	Ammoniated Bone Superphosphate,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
259	Bay State G G,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.
260	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
262	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
264	Connecticut Wrapper Fertilizer,	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
265	Coarse Linseed Meal,	Cleveland Linseed Oil Company, Cleveland, Ohio,	South Deerfield.
268	Onion Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
269	Corn and Grain Phosphate,	Cleveland Dryer Company, Boston, Mass.,	Monson.
271	Lawn and Garden Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
273	High-grade General Fertilizer,	Pacific Guano Company, Boston, Mass.,	Belchertown.

	Chemicals.		
24	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
25	Nitrate of Soda,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
50	Sulphate of Potash and Magnesia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
59	Sulphate of Potash and Magnesia,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
	Bones.		
207	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amherst.
231	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amesbury.
240	Ground Bone,	Bryant & Brett, New Bedford, Mass.,	Amherst.
256	Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.							POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
								TOTAL.		AVAILABLE.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
210	New Rival Ammoniated Superphosphate, .	11.25	1.26	1.20—2.00	5.01	3.69	1.79	10.49	11—14	8.70	10—12	2.32	1.60 3.00
213 223	New Method Fertilizer, ...	12.83	1.33	.82—1.65	5.12	3.53	1.43	10.08	10—12	8.65	8—10	2.20	2.16—3.24
217	Lawn Fertilizer, ...	3.75	2.49	3.29—4.00	-	8.92	17.92	26.84	19—22	8.92	-	1.30	3.25—4.30
236	Prolific Crop Producer, ...	12.97	1.19	.82—1.65	4.86	3.70	2.18	10.74	7—11	8.56	6—9	2.17	1—2
248	Standard Superphosphate, ...	11.78	2.48	2.5—3.5	4.09	5.32	2.10	11.51	11—16	9.41	9—13	2.00	2—3
251 260	Corn Manure, ...	7.54	4.19	4.12	2.92	4.04	1.74	8.70	-	6.96	6.25	7.50	7
253	Ammoniated Bone Superphosphate, . .	15.70	2.88	2.50—3.50	3.96	2.68	1.80	8.44	7—8	6.64	6—7	6.02	5—6
259	Bay State "G G,"	12.32	2.41	1.85—2.68	6.02	3.06	3.46	12.54	10—13	9.08	8.50—11	1.88	2—3
262	Dry Ground Fish Guano, ...	8.85	8.60	8—10	.52	4.40	2.82	7.74	6—8	4.92	4—6	-	-
264	Connecticut Wrapper Fertilizer, . . .	5.90	4.16	4.5—5.25	.52	4.46	2.56	7.54	5.70—6.20	4.98	-	13.18	10—11
265	Coarse Linseed Meal, ...	9.27	6.54	5.90—6.00	-	-	-	2.10	2	-	-	1.71	1.40—1.50
268	Onion Manure, ...	10.12	3.38	3.30—4.12	2.44	4.98	3.58	11.00	9—13	7.42	8—11	7.66	7—8*

<table>
<tr><td>269</td><td>Corn and Grain Phosphate,</td><td>15.88</td><td>1.97</td><td>2.02—2.88</td><td>5.17</td><td>4.60</td><td>.72</td><td>10.49</td><td>10.50—14.50</td><td>9.77</td><td>9.50—12.50</td><td colspan="2">2.44</td><td colspan="2">1.50—2.50</td></tr>
<tr><td>271</td><td>Lawn and Garden Fertilizer,</td><td>10.27</td><td>3.58</td><td>4.94—6.59</td><td>4.78</td><td>2.20</td><td>3.38</td><td>10.36</td><td>10—12</td><td>6.98</td><td>-</td><td colspan="2">5.77</td><td colspan="2">5—6</td></tr>
<tr><td>273</td><td>High-grade General Fertilizer,</td><td>11.18</td><td>3.64</td><td>2.68—3.50</td><td>3.33</td><td>4.04</td><td>2.30</td><td>9.67</td><td>9—13</td><td>7.37</td><td>8—11</td><td colspan="2">6.36</td><td colspan="2">7—8*</td></tr>
<tr><td></td><td><i>Chemicals.</i></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>24</td><td>Nitrate of Soda,</td><td>.76</td><td>15.68</td><td>15.66—16.48</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>25</td><td>Nitrate of Soda,</td><td>.97</td><td>16.04</td><td>15.66—16.48</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>50</td><td>Sulphate of Potash and Magnesia,</td><td>2.01</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">25.08</td><td colspan="2">25.94—28.10</td></tr>
<tr><td>59</td><td>Sulphate of Potash and Magnesia,</td><td>4.31</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">28.63</td><td colspan="2">25.94—28.10</td></tr>
<tr><td></td><td><i>Bones.</i></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">MECHANICAL ANALYSIS.</td></tr>
<tr><td>207
231</td><td>Pure Ground Bone,</td><td>11.92</td><td>3.42</td><td>-</td><td>-</td><td>3.96</td><td>5.38</td><td>9.34</td><td>-</td><td>3.96</td><td>-</td><td>Fine.
32.54</td><td>Med. Fine.
24.05</td><td>Med.
36.81</td><td>Coarse Med.
6.60</td></tr>
<tr><td>240</td><td>Ground Bone,</td><td>3.92</td><td>2.90</td><td>2.50</td><td>.38</td><td>7.45</td><td>18.54</td><td>26.37</td><td>25.56</td><td>7.83</td><td>-</td><td>26.53</td><td>26.80</td><td>31.77</td><td>14.90</td></tr>
<tr><td>256</td><td>Ground Bone,</td><td>7.27</td><td>4.36</td><td>3.30—3.71</td><td>.67</td><td>8.64</td><td>11.64</td><td>20.95</td><td>22—25</td><td>9.31</td><td>-</td><td>38.58</td><td>44.23</td><td>17.14</td><td>-</td></tr>
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* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Chemicals.		
13	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
23	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
44	Dried Blood,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
48	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
49	Sulphate of Potash, "High Grade,"	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
52	Sulphate of Ammonia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
54	Sulphate of Ammonia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
57	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
72	Sulphate of Potash, "High Grade,"	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
75	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
118	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
128	Nitrate of Soda,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
153	Muriate of Potash,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
191	Nitrate of Soda,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
216	Sulphate of Ammonia,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
224	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
225	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
232	Nitrate of Soda,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
249	Muriate of Potash,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
254	Nitrate of Soda,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Concluded.*

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN.		POTASSIUM OXIDE.	
			Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.					
13	Muriate of Potash,	1.03	-	-	51.08	50.54—53.70
23	Muriate of Potash,	1.37	-	-	50.52	50.54—53.70
44	Dried Blood,	5.56	9.70	9.89—11.53	-	-
48	Muriate of Potash,	.75	-	-	52.20	50.54—53.70
49	Sulphate of Potash, "High Grade,"	.33	-	-	50.80	48.64—51.34
52	Sulphate of Ammonia,	.33	20.81	20.60—21.42	-	-
54	Sulphate of Ammonia,	2.20	19.79	19.78—20.60	-	-
57 224	Nitrate of Soda,	1.27	15.87	15.48—15.81	-	-
72	Sulphate of Potash, "High Grade,"	.47	-	-	49.56	48.63—51.33
75	Muriate of Potash,	.14	-	-	52.36	50.54—53.70
118	Muriate of Potash,	.96	-	-	51.48	50.54—53-70
128	Nitrate of Soda,	1.58	16.22	14.83—16.48	-	-
153	Muriate of Potash,	.53	-	-	48.24	50.54—53.70
191	Nitrate of Soda,	1.26	15.32	14.82—15.64	-	-
216	Sulphate of Ammonia,	.25	20.84	20.60—21.42	-	-
225	Nitrate of Soda,	2.35	15.48	15.48—15.81	-	-
232	Nitrate of Soda,	1.27	16.02	-	-	-
249	Muriate of Potash,	2.65	-	-	51.72	50.54—53.70
254	Nitrate of Soda,	1.35	15.45	15.66	-	-

5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.

Wood Ashes.

[I., II. and III., sent on from Concord, Mass.; IV. and V., sent on from Lowell, Mass.; VI., sent on from Amherst, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI
Moisture at 100° C., .	6.75	15.38	6.05	23.00	19.10	7.97
Calcium oxide, . .	42.72	43.00	–	33.88	30.32	18.70
Phosphoric acid, . .	1.66	1.10	1.43	1.02	1.02	2.04
Potassium oxide, .	6.02	5.23	6.54	3.01	5.18	7.48
Insoluble matter, . .	7.71	8.84	9.74	10.88	13.38	22.03

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Concord Junction, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Rock Bottom, Mass.; VI., sent on from Walpole, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	14.96	9.86	5.93	1.29	14.69	16.06
Calcium oxide, . .	29.52	32.74	40.48	32.26	–	–
Phosphoric acid, . .	1.79	1.48	1.77	4.04	1.28	1.33
Potassium oxide, .	5.25	6.17	7.84	9.20	5.04	5.20
Insoluble matter, .	13.18	18.96	7.21	11.22	12.29	14.31

Wood Ashes.

[I., sent on from North Andover, Mass.; II., sent on from Hudson, Mass.; III., sent on from Westborough, Mass.; IV., V. and VI., sent on from Concord, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	19.11	.19	22.26	7.80	14.52	16.08
Calcium oxide, .	38.20	36.70	30.24	33.00	36.50	32.61
Potassium oxide, .	5.98	3.96	5.04	4.47	5.13	4.50
Phosphoric acid, . .	1.28	.90	1.15	1.13	1.68	1.22
Insoluble matter, .	13.12	14.61	–*	10.28	11.03	13.70

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Beverly, Mass.; II., sent on from Boston, Mass.; III. and IV., sent on from Concord, Mass.; V. and VI., sent on from Waltham, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI
Moisture at 100° C., .	6.44	2.52	11.61	4.88	.57	10.92
Calcium oxide, . .	–*	34.46	35.05	30.20	28.17	33.13
Potassium oxide, .	5.28	4.31	4.59	4.80	6.02	4.46
Phosphoric acid, . .	1.28	.67	.87	1.41	1.65	1.42
Insoluble matter, .	15.40	12.63	15.97	15.61	16.87	23.65

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Granby, Mass.; IV., sent on from Lakeville, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from Leverett, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	9.67	11.13	20.51	6.45	12.59	16.69
Phosphoric acid, . .	1.43	1.43	1.36	.51	.82	1.59
Potassium oxide, .	7.32	5.22	5.62	5.96	7.54	5.98
Insoluble matter, .	8.94	23.13	17.08	–*	–*	–*

Wood Ashes.

[I., sent on from Concord, Mass.; II. and III., sent on from Beverly, Mass.; IV. and V., sent on from South Deerfield, Mass.; VI., sent on from South Sudbury, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	12.32	10.17	2.05	2.33	13.65	33.23
Phosphoric acid, . .	1.42	1.61	1.79	1.54	1.46	.90
Potassium oxide, .	6.40	5.21	4.64	6.09	4.68	4.09
Insoluble matter, .	10.27	–*	–*	–*	–*	9.79

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I. and II., sent on from Waltham, Mass.; III. and IV., sent on from Northfield, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from South Hadley, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	11.75	9.25	12.20	6.25	20.60	2.35
Phosphoric acid, . .	1.71	1.38	1.33	1.33	1.56	1.71
Potassium oxide, .	5.10	4.32	5.18	4.65	4.78	3.46
Insoluble matter, .	–*	23.78	17.16	24.44	–*	–*

Wood Ashes.

[I., sent on from South Sudbury, Mass.; II., sent on from South Framingham, Mass.; III., sent on from South Amherst, Mass.; IV., sent on from Concord, Mass.; V., sent on from North Hadley, Mass.; VI., sent on from West Northfield, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	11.77	3.23	17.20	10.38	11.41	18.30
Phosphoric acid, . .	1.44	1.26	1.66	1.28	1.62	1.40
Potassium oxide, .	5.20	4.12	4.24	5.76	6.12	5.20
Insoluble matter, .	19.40	–*	13.05	–*	9.34	8.87

Wood Ashes.

[I. and II., sent on from Beverly, Mass.; III., sent on from Lawrence, Mass.; IV., sent on from Danvers, Mass.; V., sent on from Lunenburg, Mass.; VI., sent on from Arlington, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	2.62	6.10	19.52	10.87	18.73	7.05
Phosphoric acid, . .	1.28	1.54	1.50	.56	1.02	1.36
Potassium oxide, .	4.73	5.84	6.04	6.32	8.71	5.81
Insoluble matter, .	–*	8.85	12.48	20.22	10.94	23.82

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Bernardston, Mass.; II., sent on from Concord, Mass.; III., sent on from Amherst, Mass.; IV., sent on from Methuen, Mass.; V. and VI., sent on from Concord, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	20.58	12.32	7.57	15.39	13.60	17.80
Phosphoric acid,	1.36	1.42	1.60	1.80	1.18	1.36
Potassium oxide,	3.68	6.40	8.50	4.60	5.39	5.75
Insoluble matter,	9.80	10.27	8.48	–*	17.48	10.36

Wood Ashes.

[All sent on from Concord, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	15.22	21.36	19.48
Phosphoric acid,	1.07	–	.98
Potassium oxide,	5.07	1.20	6.08
Insoluble matter,	12.46	3.66	9.90

Cotton-hull Ashes.

[I., sent on from North Hadley, Mass.; II. and III., sent on from Hatfield, Mass.; IV., sent on from Sunderland, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.72	9.45	11.00	7.89
Phosphoric acid,	9.40	9.96	6.84	5.46
Potassium oxide,	25.50	25.48	15.40	26.36
Insoluble matter,	6.08	–*	–*	–*

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Lime-kiln Ashes.

[I., sent on from Sunderland, Mass.; II. and III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	.68	24.09	15.01
Phosphoric acid,	1.48	1.57	.77
Potassium oxide,	5.20	1.57	.77
Calcium oxide,	–*	36.69	45.28
Insoluble matter,	–*	11.76	3.31

* Not determined.

Swill Ashes (from Cremation Furnace).

[Sent on from Amherst, Mass.]

	PER CENT.						
	I.	II.	III.	IV.	V.	VI.	VII.
Moisture at 100° C.,	2.43	19.46	12.48	.37	7.57	14.24	8.05
Potassium oxide,	1.59	1.78	3.35	4.27	3.96	5.09	4.92
Phosphoric acid,	25.89	5.22	6.50	12.97	13.92	6.86	13.22
Insoluble matter,	17.93	30.81	31.54	34.91	19.96	37.76	24.52

Lime and Ashes.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	.65
Calcium oxide,	57.17
Potassium oxide,	.77
Phosphoric acid,	1.02
Insoluble matter,	13.86

Coal Ashes.

[Sent on from Framingham.]

	Per Cent.
Moisture at 100° C.,	32.37
Potassium oxide,	.42
Phosphoric acid,	.37
Nitrogen,	.33
Insoluble matter,	34.52

5. ANALYSES, ETC. — *Continued.*

Refuse Materials.

[I., refuse from calico works, sent on from Seekonk, Mass.; II., hair waste, sent on from Concord, Mass.; III. and IV., cotton waste, sent on from Concord, Mass.; V., wool waste, sent on from Lawrence, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.07	72.81	10.01	10.93	2.23
Phosphoric acid,	11.95	.61	.31	1.80	.38
Potassium oxide,	–	.32	1.20	1.51	3.50
Nitrogen,	4.28	1.79	3.43	9.33	.96

Muck.

[Sent on from North Wilbraham, Mass.; I., light colored; II., dark colored.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	53.06	80.42
Calcium oxide,	.73	.22
Potassium oxide,	.05	.06
Phosphoric acid,	.04	.05
Nitrogen,	.52	.44
Insoluble matter,	38.35	6.06

Muck.

[I., sent on from South Amherst, Mass.; II., sent on from Plymouth, Mass.; III., sent on from Miller's Falls, Mass.]

	PER CENT.		
	I	II.	III.
Moisture at 100° C.,	70.02	61.53	76.75
Ash,	11.54	30.05	4.38
Nitrogen,	.69	.43	.40

Soot.

[Sent on from South Lancaster, Mass.]

	Per Cent.
Moisture at 100° C.,	5.39
Potassium oxide,	.52
Phosphoric acid,	.90

5. ANALYSES, ETC. — *Continued.*

Residue from Water Filter.

[Sent on from East Walpole, Mass.]

	Per Cent
Moisture at 100° C.,	94.22
Phosphoric acid,	.05
Nitrogen,	.12

Vegetable Mould.

[Sent on from Springfield, Mass.]

	Per Cent.
Moisture at 100° C.,	77.64
Nitrogen,	.30

Soot.

[Sent on from Lynn, Mass.; I., black; II., brown.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	2.09	.13
Phosphoric acid,	.74	2.10
Potassium oxide,	.46	.59
Nitrogen,	1.05	–

Barnyard Manure.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	72.080
Phosphoric acid,	.304
Potassium oxide,	.641
Nitrogen,	.541
Insoluble matter,	2.730

Goose Manure.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	49.820
Phosphoric acid,	.957
Potassium oxide,	.810
Nitrogen,	.213

5. ANALYSES, ETC. — *Continued.*

Hen House Refuse.

[Sent on from Fitchburg, Mass.]

	Per Cent.
Moisture at 100° C.,	3.43
Phosphoric acid,	1.28
Potassium oxide,	.60
Nitrogen,	.98

Waste Lime.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	.80
Calcium oxide,	74.12
Insoluble matter,	.38

Potash Magnesia Sulphate.

[Sent on from Hatfield, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	5.34	4.73	1.19
Potassium oxide,	26.80	26.32	27.28

Muriate of Potash.

[I. and II., sent on from Sunderland, Mass.; III., sent on from Leverett, Mass.; IV., sent on from Hudson, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.91	.13	1.20	1.05
Potassium oxide,	52.50	49.00	52.60	51.16

5. Analyses, etc. — *Continued.*

Florida Phosphate.

[I., soft variety, sent on from Boston, Mass.; II., sent on from Brookline, Mass.; III., sent on from South Hadley Falls, Mass.; IV., soft variety, sent on from South Chelmsford, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	3.35	1.20	3.69	9.03
Calcium oxide,	30.22	32.80	–*	–*
Phosphoric acid,	19.94	24.49	20.79	18.54
Ferric and aluminic oxides,	9.96	6.93	–*	–*
Potassium oxide,	.29	–	–	–
Insoluble matter,	30.86	23.91	25.48	26.55

* Not determined.

Tankage.

[I., II., III., IV. and V., sent on from Boston, Mass.; VI., sent on from Concord, Mass.]

	Per Cent.					
	I.	II.	III	IV.	V.	VI.
Moisture at 100° C.,	9.24	9.23	14.95	9.01	6.27	10.33
Phosphoric acid,	10.84	12.28	10.23	12.60	11.26	4.03
Nitrogen,	6.94	8.27	8.72	8.26	7.51	9.16

Fish Waste.

[I., II. and III., sent on from Gloucester, Mass.; IV. and V., sent on from Boston, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.37	6.17	6.86	20.71	11.95
Phosphoric acid,	8.96	5.38	11.90	15.91	13.93
Nitrogen,	10.80	11.08	9.12	5.97	7.69

5. ANALYSES, ETC. — *Continued.*

Ground Bone.

[I., sent on from West Berlin, Mass.; II., III., IV. and V., sent on from Lincoln, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.97	3.76	4.31	4.01	3.64
Total phosphoric acid,	15.81	28.78	28.66	25.64	20.98
Available phosphoric acid,	15.71	–	–	–	–
Insoluble phosphoric acid,	.10	–	–	–	–
Nitrogen,	2.82	3.50	3.54	4.21	3.23

Ground Bone.

[I., sent on from Salisbury, Mass.; II., sent on from Townsend Harbor, Mass.; III., sent on from West Newbury, Mass.; IV., dissolved bone, sent on from Lancaster, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	34.55	5.84	3.95	8.79
Total phosphoric acid,	11.42	27.90	26.55	14.12
Available phosphoric acid,	–*	26.51	21.75	13.61
Insoluble phosphoric acid,	–*	1.39	4.80	.51
Nitrogen,	4.04	2.87	2.09	.59
Mechanical Analysis.				
Fine bone,	–*	39.27	58.35	–*
Fine medium bone,	–*	32.43	25.95	–*
Medium bone,	–*	25.00	15.70	–*
Coarse medium bone,	–*	3.30	–	–*
	–	100.00	100.00	–

* Not determined.

Cotton-seed Meal.

[I. and II., sent on from Hatfield, Mass.; III., sent on from Hadley, Mass. (damaged); IV., sent on from Amherst, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.75	8.23	12.57	9.01
Total phosphoric acid,	2.12	3.08	2.48	2.11
Potassium oxide,	1.51	1.94	1.66	2.38
Nitrogen,	7.70	7.17	5.68	7.11

5. ANALYSES, ETC. — *Concluded.*

Commercial Fertilizers (Complete).

[I. and II., sent on from Granby, Mass.; III., sent on from Dighton, Mass.; IV., sent on from Concord, Mass.; V., sent on from Hatfield, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	12.81	12.46	8.29	19.76	6.20
Total phosphoric acid, . .	10.62	9.39	11.85	10.59	2.89
Soluble phosphoric acid, . .	.26	5.99	6.12	1.97	–
Reverted phosphoric acid, .	10.01	2.43	4.61	7.01	1.56*
Insoluble phosphoric acid, .	.35	.97	1.13	1.64	1.33
Potassium oxide, . . .	2.78	10.03	10.11	3.78	11.26
Nitrogen, ...	2.28	3.55	3.69	3.13	4.05

* Available.

Commercial Fertilizers (Complete).

[I., sent on from Hatfield, Mass.; II., sent on from Pittsfield, Mass.; III, sent on from Lancaster, Mass.; IV., sent on from Hatfield, Mass.; V., sent on from East Lexington, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . .	5.61	11.07	10.39	6.54	5.36
Total phosphoric acid, . .	6.75	11.82	10.64	12.62	8.37
Available phosphoric acid, .	–*	11.31	8.77	–*	6.91
Insoluble phosphoric acid, .	–*	.51	1.87	–*	1.46
Potassium oxide, . . .	9.12	5.26	5.86	11.82	9.44
Nitrogen, ...	2.60	3.02	2.29	5.42	2.90

* Not determined.

Commercial Fertilizers (Complete).

[I., sent on from East Lexington, Mass.; II., III., IV. and V., sent on from Eastham, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	5.63	.76	19.76	15.21	9.17
Total phosphoric acid, . .	5.94	27.12	2.82	.64	14.96
Available phosphoric acid, .	4.35	1.40	2.30	.64	14.70
Insoluble phosphoric acid, .	1.59	25.72	.52	–	.26
Potassium oxide, . . .	6.08	1.48	9.00	9.32	1.51
Nitrogen, ...	2.16	.06	1.35	2.18	.09

6. MISCELLANEOUS ANALYSES.

Cooking Soda.

[Sent on from South Acton, Mass.]

	Per Cent.
Total carbonic acid,	48.25
Available carbonic acid,	15.25
Sulphuric acid,	.31
Hydrochloric acid,	.23
Insoluble matter,	Trace.

Baking Powder.

[Sent on from North Amherst, Mass.]

	Per Cent.
Available carbonic acid,	8.40
Aluminic oxide,	3.49
Phosphoric acid,	4.76
Ammonia,	.75
Sulphuric acid,	5.41
Calcium oxide,	6.08

Soil Deposit.

[Sent on from Shirley, Mass.]

	Per Cent.
Moisture at 100° C.,	6.13
Calcium oxide,	.38
Ferric and aluminic oxides,	.79
Potassium oxide,	.18
Phosphoric acid,	.04
Insoluble matter,	83.18

Soil.

[Sent on from Gardner, Mass.]

	Per Cent.
Moisture at 100° C.,	8.33
Calcium oxide,	.44
Ferric and aluminic oxides,	1.20
Potassium oxide,	.18
Phosphoric acid,	.14
Nitrogen,	.87
Insoluble matter,	58.49

7. Miscellaneous Fodder Analyses.

A. Analyses of Food Articles (Human Food).

Quaker Self-raising Buckwheat Flour.

[Sent on from Ravenna, O.]

	Per Cent.
Moisture at 100° C.,	13.36
Dry matter,	86.64
	100.00

Analysis of Dry Matter.

Crude ash,	5.21
" fibre,	.42
" fat,	.90
" protein,	6.35
Nitrogen-free extract matter,	87.12
	100.00

Hecker's Hominy.

[Sent on from New York, N. Y.]

	Per Cent.
Moisture at 100 C.,	9.56
Dry matter,	90.44
	100.00

Analysis of Dry Matter.

Crude ash,	.22
" fibre,	.45
" fat,	.83
" protein,	9.02
Nitrogen-free extract matter,	89.48
	100.00

Macaroni (Royal Egg Brand).

[Sent on from Minneapolis, Minn.]

	Per Cent.
Moisture at 100° C.,	9.07
Dry matter,	90.93
	100.00

Analysis of Dry Matter.

Crude ash,	–
" fibre,	.34
" fat,	.57
" protein,	12.88
Nitrogen-free extract matter,	86.21
	100.00

Farina (a Wheat Product).

[Sent on from Wilmington, Del.]

	Per Cent.
Moisture at 100° C.,	10.65
Dry matter,	89.35
	100.00

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Analysis of Dry Matter.

	Per Cent.
Crude ash,	.06
" fibre,	.74
" fat,	1.98
" protein,	11.62
Nitrogen-free extract matter,	85.60
	100.00

Condensed Milk.

[No. 1, Milkmaid Brand; No. 2, Eagle Brand.]

	PER CENT.	
	No. 1.	No. 2.
Moisture at 100° C.,	24.48	26.38
Total solids,	75.52	73.62
Fat,	8.95	7.01
Cosein,	9.31	–*
Milk sugar,	13.04	10.04
Cane sugar,	37.43	42.46

Gelatine.

[Sent on from Johnstown, N. Y.]

	PER CENT.			
	No. 1.	No. 2.	No. 3.	Rose-colored.
Moisture at 100° C.,	15.39	15.36	13.94	14.09
Nitrogen,	14.28	14.28	14.68	14.40
Ash,	1.40	1.48	1.88	1.74

*Thacher's Sugar of Milk Baking Powder.**

	Per Cent.
Available carbonic acid,	13.96
Milk sugar,	3.80

Peanut Meal.

[Sent on from Washington, D. C.]

	Per Cent.
Moisture at 100° C.,	8.00
Dry matter,	92.00
	100.00

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* Completely soluble in water.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Analysis of Dry Matter.	Per Cent.
Crude ash,	4.29
" fibre,	3.76
" fat,	11.69
" protein,	53.26
Nitrogen-free extract matter,	27.00
	100.00
Fertilizing Constituents.	
Moisture at 100° C.,	8.00
Potassium oxide,	1.27
Phosphoric acid,	1.54
Nitrogen,	7.84

B. Analyses of Fodder Articles.

The names of the articles described below are those given by the parties sending them for analysis. As the food value of concentrated feed stuffs depends materially on the amount of crude protein and crude fat present, the analysis has been confined in several instances to the determination of these two constituents.

[I., cotton-seed meal, sent on from North Amherst, Mass.; II., cotton-seed meal, sent on from Hatfield, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.99	9.45
Dry matter,	91.01	90.55
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.10	–*
" fibre,	5.53	–*
" fat,	9.66	11.20
" protein,	50.34	40.92
Nitrogen-free extract matter,	27.37	–*
	100.00	–
Fertilizing Constituents.		
Moisture at 100° C.,	8.99	9.45
Phosphoric acid,	–*	3.65
Potassium oxide,	–*	2.34
Nitrogen,	7.33	5.93

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., cotton-seed meal (undecorticated), sent on from Hatfield, Mass.; II., cotton-seed bran, sent on from New York, N. Y.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	10.77	10.10
Dry matter,	89.23	89.90
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	–*	3.58
" fibre,	–*	31.09
" fat,	5.41	3.17
" protein,	23.69	11.82
Nitrogen-free extract matter,	–*	50.34
	–	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	10.77	10.10
Phosphoric acid,	2.04	–*
Potassium oxide,	2.18	–*
Nitrogen,	3.38	1.70

[I., Chicago gluten meal, sent on from Amherst, Mass.; II., Chicago gluten meal, sent on from Boston, Mass.; III., King gluten meal, from station barn.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	9.33	10.22	7.18
Dry matter,	90.67	89.78	92.22
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.14	–*	1.50
" fibre,	1.73	–*	1.41
" fat,	4.60	8.74	19.68
" protein,	37.09	43.86	38.57
Nitrogen-free extract matter,	56.44	–*	38.84
	100.00	–	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Atlas Meal.

[Dry distillery feed, sent on from Peoria, Ill.]

	Per Cent.
Moisture at 100° C.,	11.21
Dry matter,	88.75
	100.00
Analysis of Dry Matter.	
Crude ash,	.41
" fibre,	11.94
" fat,	15.28
" protein,	37.30
Nitrogen-free extract matter,	35.07
	100.00
Fertilizing Constituents.	
Moisture at 100° C.,	11.21
Potassium oxide,	.16
Phosphoric acid,	.23
Nitrogen,	5.30

This article is new in our market. German experiment station reports speak of two kinds of dry distillery feed, one obtained in connection with the manufacture of alcohol from rye and one from maize; the former contains considerable less crude protein (from twenty-two to thirty per cent.) than the latter (from thirty to thirty-four per cent.).

[I., Buffalo gluten feed, from station barn; II., golden gluten, sent on from Boston, Mass.; III., Chicago maize feed, sent on from Boston, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	8.34	9.89	7.19
Dry matter,	91.66	90.11	92.81
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.91	-*	1.06
" fibre,	8.61	-*	9.34
" fat,	14.76	15.78	7.39
" protein,	25.09	29.13	27.07
Nitrogen-free extract matter,	50.63	-*	55.14
	100.00	-	100.00

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., gluten feed, sent on from Lincoln, Mass.; II, oil cake, sent on from Boston, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.52	11.01	8.52
Dry matter,	91.48	88.99	91.48
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	–*	2.35	–*
" fibre,	–*	8.37	–*
" fat,	15.94	18.32	14.58
" protein,	24.21	25.21	22.15
Nitrogen-free extract matter,	–*	45.75	–*
	–	100.00	–

[I., Peoria gluten feed, sent on from Peoria, Ill.; II., Chicago gluten, sent on from Lincoln, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.07	9.22	9.79
Dry matter,	92.93	90.78	90.21
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	1.16	–*	–*
" fibre,	8.30	–*	–*
" fat,	14.33	8.98	9.07
" protein,	22.71	22.87	21.00
Nitrogen-free extract matter,	53.50	–*	–*
	100.00	–	–

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* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., combination horse feed, sent on from Amherst, Mass.; II., corn, oats and barley chop, sent on from Springfield, Mass.; III., ground corn and oats chop, sent on from Springfield, Mass.; IV., Iowa gluten meal, sent on from Amherst, Mass.; V., cotton-seed meal, sent on from Amherst, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.84	9.85	7.98	8.31	7.29
Dry matter,	89.16	90.15	92.02	91.69	92.71
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	5.69	4.14	2.35	1.24	7.63
" cellulose,	19.92	8.48	14.62	4.52	5.91
" fat,	1.74	5.54	3.83	10.97	8.41
" protein,	11.22	13.75	9.13	36.40	48.79
Nitrogen-free extract matter,	61.43	68.09	70.07	46.87	29.26
	100.00	100.00	100.00	100.00	100.00

[I., Chicago maize feed, sent on from Boston, Mass.; II., Peoria gluten feed, sent on from Peoria, Ill.; III., Buffalo gluten feed, from station barn; IV., wheat bran, from station barn; V., barley meal, from station barn.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.19	7.07	9.37	9.15	11.17
Dry matter,	92.81	92.93	90.63	90.85	88.83
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	1.06	1.16	.86	6.10	2.79
" cellulose,	9.34	8.30	8.17	11.06	8.03
" fat,	7.39	14.33	14.71	6.10	2.51
" protein,	27.07	22.71	23.16	18.29	9.99
Nitrogen-free extract matter,	55.14	53.50	53.10	58.45	76.68
	100.00	100.00	100.00	100.00	100.00

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I. and II., cotton-seed meal, sent on from Longmeadow, Mass.; III., cotton-seed meal, sent on from Williamsburg, Mass.; IV., Chicago germ feed, sent on from Weston, Mass.; V., oat feed, sent on from North Amherst, Mass.: VI., ground oats, sent on from North Amherst, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	5.87	5.82	6.35	7.35	6.75	8.89
Dry matter,	94.13	94.18	93.65	92.65	93.25	91.11
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude fat,	11.55	10.85	9.30	13.18	4.83	4.52
" protein,	50.19	47.78	51.38	11.06	11.93	11.93

[I., gluten feed, sent on from Lincoln, Mass.; II., gluten feed, sent on from Lincoln, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.52	8.61
Dry matter,	91.48	91.39
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	–*	–*
" fibre,	–*	–*
" fat,	14.59	12.70
" protein,	22.15	16.81
Nitrogen-free extract matter,	–*	–*

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., peanut cake (Germany); II., peanut husks from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C,	–	12.98
Dry matter,	–	87.02
	–	100.00
Analysis of Dry Matter.		
Crude ash,	–	1.36
" fibre,	–	75.91
" fat,	8—12	1.90
" protein,	42—52	5.74
Nitrogen-free extract matter,	–	15.09
	–	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	–	12.98
Phosphoric acid,	–	.13
Potassium oxide,	–	.48
Nitrogen,	6—8	.80

[I., Peoria gluten feed, sent on from North Amherst, Mass.; II., King gluten meal, sent on from New York, N. Y.; III., Iowa gluten meal, sent on from Beverly, Mass.; IV., rye feed, sent on from Westborough, Mass.; V., oat feed, from station barn.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.50	6.65	7.33	8.23	6.50
Dry matter,	92.50	93.35	92.67	91.77	93.50
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	.90	2.19	–*	3.34	10.02
" cellulose,	8.86	1.62	–*	3.62	17.73
" fat,	13.62	21.44	16.08	3.04	3.95
" protein,	21.35	36.19	31.56	16.62	11.02
Nitrogen-free extract matter,	55.27	38.56	–*	73.38	57.28
	100.00	100.00	–	100.00	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., peanut feed, sent on from Granby, Mass.; II., peanut feed, sent on from Boston, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	9.08	10.92
Dry matter,	90.92	89.08
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	2.25	3.60
" fibre,	62.48	62.82
" fat,	7.61	4.49
" protein,	10.31	9.54
Nitrogen-free extract matter,	17.35	19.55
	100.00	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	9.07	10.92
Phosphoric acid,	.23	–*
Potassium oxide,	.79	–*
Nitrogen,	1.50	1.36

[I., meat meal, sent on from New York; II., German analysis, sent on.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.00	–
Dry matter,	92.00	–
	100.00	–
Analysis of Dry Matter.		
Crude ash,	–*	–
" fibre,	–*	–
" fat,	20.73	12.70
" protein,	76.15	73.50
Nitrogen-free extract matter,	–*	–
Fertilizing Constituents.		
Moisture at 100° C.,	8.00	–
Phosphoric acid,	.73	–
Potassium oxide,	.30	–
Nitrogen,	11.21	11.70

* Not determined.

This meal is a refuse from the manufacture of Liebig's extract of meat. In the process of manufacture it has lost its salines, and in feeding the meal these are replaced in the form of chemicals.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., late soja bean, station, cut July 10, 1893, twelve to thirteen inches high, not in bloom; II., early black soja bean, station, cut July 10, 1893, sixteen to seventeen inches high, on point of blooming; III., early white soja bean, station, cut July 10, 1893, fourteen inches high, just before blooming; IV., early white soja bean, station, cut July 10, 1893, sixteen to seventeen inches high, before blooming.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	77.09	82.21	79.51	74.97
Dry matter,	22.91	17.79	20.49	25.03
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	14.36	12.86	14.36	11.85
" cellulose,	16.47	25.06	23.41	23.23
" fat,	3.34	3.38	2.97	2.16
" protein,	22.16	16.18	14.34	13.81
Nitrogen-free extract matter,	43.67	42.52	44.92	48.95
	100.00	100.00	100.00	100.00
Total nitrogen,	3.54	2.59	2.29	2.21
Amide nitrogen,	.79	.55	.68	.31

[I., rowen from station barn; II., carrots, raised on station grounds; III., beets, raised on station grounds.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	18.64	88.01	83.71
Dry matter,	81.36	11.99	16.29
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	7.62	7.98	6.79
" cellulose,	26.09	9.00	5.84
" fat,	3.28	2.03	.71
" protein,	14.42	7.29	13.27
Nitrogen-free extract matter,	48.59	73.70	73.39
	100.00	100.00	100.00
Fertilizing Constituents.			
Moisture at 100° C.,	18.640	88.010	83.710
Potassium oxide,	1.682	.441	.463
Phosphoric acid,	.574	.095	.111
Nitrogen,	1.876	.140	.346
Insoluble matter,	1.533	.029	.111

7. MISCELLANEOUS FODDER ANALYSES — *Concluded.*

[I., potatoes, station, raised on Plat 1, Field C, with muriate of potash; II., potatoes, station, raised on Plat 4, Field C, with sulphate of potash; III., potatoes from station barn.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	80.71	81.17	78.67
Dry matter,	19.29	18.83	21.33
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	4.71	4.64	4.76
" fibre,	2.26	2.35	2.30
" fat,	.54	.42	.62
" protein,	10.98	10.06	9.56
Nitrogen-free extract matter,	81.51	82.53	82.76
	100.00	100.00	100.00
Starch,	13.44	13.15	–*
Starch in dry matter,	69.66	70.31	–*
Fertilizing Constituents.			
Moisture at 100° C.,	80.710	81.170	78.670
Calcium oxide,	.018	.020	–*
Magnesium oxide,	.044	.041	–*
Potassium oxide,	.607	.553	.589
Sodium oxide,	.029	.024	–*
Phosphoric acid,	.065	.048	.134
Nitrogen,	.338	.303	.326
Insoluble matter,	.026	.048	.036

* Not determined.

Apple Pomace.

[Sent on from Sherborn, Mass.]

	Per Cent.
Moisture at 100° C.,	87.51
Dry matter,	12.49
	100.00
Analysis of Dry Matter.	
Crude ash,	3.36
" fibre,	21.67
" fat,	5.93
" protein,	5.75
Nitrogen-free extract matter,	63.29
	100.00

C. Discussion on Commercial Feed Stuffs.

By C. A. Goessmann.

The name commercial feed stuff or concentrated commercial feed stuffs is usually applied to a class of substances offered for sale in our markets which, in the majority of cases, are the waste or by-products of other branches of industry. Some of these articles, as brans, middlings and oil cakes, have been for years quite generally used in the daily diet of all kinds of farm live stock; others, as the gluten meal, gluten feed, corn germ meal, dried brewers' grain, malt sprouts, dry distillery feed, etc., have been but recently more generally offered for a similar purpose.

Their importance as an additional valuable fodder supply for the support of every branch of animal industry on the farm and elsewhere has become from year to year more conspicuous, on account of a marked increase of the supply of well-known articles, as well as of the introduction of many new kinds. Their consumption is apparently daily increasing, and seems to keep step with the supply.

The special value claimed for commercial feed stuffs as an important source of fodder supply rests in the main on their fitness to supplement advantageously our coarse home-raised fodder crop in the interest of a higher feeding effect and of a better economy. A frequently good mechanical condition, as well as an exceptionally valuable chemical composition, adapt many of them in a high degree for that purpose.

As no single farm crop or any part of it has been found to supply economically and efficiently to any considerable extent the particular wants of food of our various kinds of farm live stock, to secure the best possible results, it becomes a matter of first importance from a mere financial stand-point to know how to supplement our current farm crops to meet the wants of each kind of animals under various circumstances in a desirable degree. To secure the highest feeding effect of each fodder article raised upon the farm is most desirable in the interest of good economy.

Practical experience in the dairy has thus far abundantly shown that the efficiency of a daily diet does not so much depend on the mere use of more or less of one or the other reputed fodder article as on the presence of suitable fodder articles which contain the *three essential groups of food constituents*, i. e., *organic nitrogenous, non-nitrogenous and mineral constituents of plants*, in a desirable form, and in such relative proportions and quantities as have been recognized to be necessary to meet efficiently the food supply of the dairy cow. Similar relations are known to exist in regard to the diet best adapted in case of all kinds of animals. *An economical system of stock feeding has to select among the suitable fodder articles those which furnish the required quality and proportion of the three recognized essential food constituents in a digestible form, at the lowest cost.*

Actual observations in stock feeding fully confirm the correctness of the above statement, that a judicious selection from among the current commercial feed stuffs, for the purpose of serving in connection with one or more of our home-raised fodder plants as a fodder ingredient of the daily diet, does, as a rule, tend not only to improve their food value, but also lowers in the majority of cases the net cost of the feed consumed. For more details regarding the determination of the intrinsic value of fodder rations I have to refer on the present occasion, for obvious reasons, to preceding annual reports.

The majority of commercial feed stuffs occupy in a rational system of stock feeding a similar position to our home-raised fodder crops as is commonly conceded to the commercial fertilizer with reference to the barn-yard manure for the production of farm crops; they serve for the preparation of a complete diet under different conditions and for different purposes. The individual merits of each of them become in the same degree better appreciated as the principles which govern animal nutrition are *more generally* understood, and *find a due recognition* in our modes of compounding the daily diet for different kinds as well as for different conditions of the same kind of animals. *They are as a class today considered indispensable for a remunerative management of every branch of animal industry on the farm and elsewhere.*

Many of the commercial feed stuffs contain, aside from a liberal amount of phosphoric acid and potash, an exceptionally large percentage of nitrogen. This circumstance gives them a special claim, independent of their respective food value for animals. A liberal addition of these feed stuffs to the daily diet of any kind of animal imparts to the manurial refuse resulting from their use a corresponding higher commercial and agricultural value as a valuable source of plant food. A judicious and liberal introduction of a quite numerous class of commercial feed stuffs into the daily fodder supply of the animals kept on the farm is for this reason *deservedly* recommended as a safe and economical way to increase the home production of plant food in the interest of an increase in the fertility of the farm lands.

As the financial success of a mixed system of farming in particular depends to a considerable degree on the character, the amount and the cost of production of the manurial refuse secured in connection with the special farm industry carried on at the time, it seems to need no further argument to prove that the relation which exists between the temporary *market cost* of the particular feed stuff under consideration and the *market value* of the manurial elements which it contains deserves a serious consideration when devising an efficient and at the same time an economical diet.

The character and commercial value of the manurial refuse obtainable from any kind of feed stuff, under otherwise corresponding conditions, stand in a direct relation to more or less of the different essential fertilizing constituents — phosphoric acid, potash and, in particular, nitrogen — it contains. The commercial value of these three important articles of plant food found frequently in prominent commercial feed stuffs equals in many instances more than one-half of the market cost of the particular fodder ingredient in question.

The subsequent tabular statement may serve as an illustration of these relations between market cost and fertilizing value of some current reputed fodder articles: —

NAME OF FEED STUFFS.	Market Cost (per Ton).	Manurial Value (per Ton).
Corn meal,	$24 00	$7 31
Gluten meal (Chicago),	28 00	14 72
Chicago maize feed,	25 00	13 25
Buffalo gluten feed,	23 00	12 57
Cotton-seed meal,	28 00	23 52
Linseed meal (old process),	26 00	19 22
Linseed meal (new process),	27 00	20 37
Wheat middlings,	17 00	9 50
Wheat bran,	17 00	13 23
Dried brewers' grain,	23 00	9 96
English hay (first cut of meadows),	15 00	5 92
Rowen (second cut of meadows),	15 00	7 00
Corn fodder,	7 00	4 55
Corn stover,	5 00	3 75
Corn ensilage,	2 50	1 53
Sugar beets,	5 00	1 21
Mangold roots,	4 00	1 01

The above-stated market cost is subject to periodical changes, and the commercial value of their fertilizing constituents varies more or less with the quality of each kind. This feature does not affect materially the force of the point made.

A due appreciation of the previously pointed out favorable features regarding the peculiar character of a numerous class of commercial feed stuffs has caused a steady increase in their consumption on the farm and elsewhere. *The money invested by farmers for securing commercial feed stuffs as an additional food supply for home consumption exceeds to-day many times the amount spent for commercial fertilizers.*

As no single commercial feed stuff can be expected to meet our present demand for these articles, nor can claim to be the most economical one under varying market conditions, and with due appreciation of the varying character of our home-raised fodder supply, it is but proper that every new addition in suitable kinds should receive a deserved attention, and subsequently an actual trial to ascertain its individual merits.

A considerable number of these feed stuffs has already been tried at this station during past years, in connection with our feeding experiments with milch cows, growing steers, lambs and pigs, as may have been noticed in our periodical reports; others are at present on trial.

Commercial feed stuffs are usually bought for their high percentage of either nitrogen-containing organic matter or fat, or both. They are used to enrich the daily diet of various kinds of farm live stock in both directions. This course is generally adopted on account of a well-known deficiency of most of our home-raised coarse fodder articles in regard to both food constituents, in particular, of nitrogenous matter. Farmers that do not raise a liberal proportion of clover-like fodder plants are in a particular degree in need of concentrated commercial feed stuffs rich in nitrogenous food constituents to turn the excess of the non-nitrogenous food constituents which most of our current home-raised coarse fodder articles contain to the best possible account.

The liability of pecuniary losses on the part of the buyer, in consequence of exceptional variations in the percentage of nitrogenous organic matter, crude protein or fat, or of both, is quite frequently greatly aggravated by most unexpected serious fluctuations in the market cost of leading feed stuffs.

As we buy in the majority of cases the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost *a given quantity of nitrogen-containing food constituents* can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the *market cost* of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent in particular, as its supply is more limited than that of the non-nitrogenous food constituents which our home-raised coarse fodder articles contain, as a rule, in abundance, and which, therefore, need not be secured from outside resources for cash.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of analyses stated are made of fodder articles which have been used either during the past years in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

Valuation of Fodder Articles on the Following Basis.

[Digestible cellulose and nitrogen-free extract matter, 1 cent per pound; digestible fat, 2½ cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds.)]

	Market Cost.	Protein per Pound (Cents).
Corn meal,	$31 00	6.88
Corn meal,	29 00	5.84
Corn meal,	24 00	3.24
Corn meal,	23 00	2.72
Wheat middlings,	20 00	3.13
Spring wheat bran,	19 00	3.04
Winter wheat bran,	21 00	3.93
Chicago maize feed,	23 00	2.34
Dried brewers' grain,	22 00	3.37
Old-process linseed meal,	26 00	2.20
New-process linseed meal,	27 00	2.68
Chicago gluten meal,	28 00	2.46
Cotton-seed meal,	28 00	2.34
English hay,	12 00	1.36
English hay,	15 00	4.12
Rowen,	12 00	1.21
Rowen,	15 00	3.24
Corn stover,*	5 00	–
Corn ensilage,*	2 50	–
Mangold roots,*	3 00	–
Sugar beets,*	5 00	–

* The value of the digestible cellulose, nitrogen-free extract matter and fat, on the above basis, exceeds the market cost.

The present condition of the trade in commercial concentrated feed stuffs deserves the serious attention of dealers and consumers for the following reasons: —

Prices are apt to rise and to fall without any reference to the agricultural value of the article in question.

Names may remain the same, and in fact do remain in some instances, while the composition of the article suffers *serious changes in consequence of changes in the parent industry.*

Sales without due responsibility regarding the particular quality of the goods delivered leave the pecuniary risk involved in the transaction in an objectionable degree on the side of the buyer.

Unaccounted-for variations in the composition of feed stuffs must prove a serious obstacle in the desirable introduction of a rational and economical system of stock feeding.

For these and other reasons previously pointed out it cannot be claimed that the prevailing mode of selling and buying commercial feed stuffs rests on a just and fairly equitable basis.

The trade in commercial feed stuffs is to-day in a similar unsatisfactory condition as was the trade in commercial fertilizers before the introduction of a system of State inspection in regard to those articles.

The best interests of both manufacturers and farmers, in fact of every one who keeps live stock for his accommodation, render such changes desirable in the present mode of selling and buying feed stuffs as will impose mutual and equitable responsibility on all parties interested in the transaction. The limited margins for profit in every branch of animal industry carried on at our farms necessitate a careful attention to all the details of the business. The money interests involved are of an exceptional magnitude.

II.

ANALYSES OF MILK SENT ON FOR EXAMINATION.

[Per Cent.]

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	12.50	3.69	8.81	Northborough.	
2, . .	12.13	4.27	7.86	Westborough.	
3, . .	12.19	4.50	7.69	Westborough.	
4, . .	11.62	4.25	7.37	Westborough.	
5, . .	12.20	3.39	8.81	Westborough.	
6, . .	13.18	4.23	8.95	Westborough.	
7, . .	12.55	3.36	9.05	New Braintree.	
8, . .	12.78	4.05	8.73	Westborough.	
9, . .	14.31	5.03	9.28	North Amherst.	
10, . .	12.85	3.51	9.34	Barre.	
11, . .	10.20	2.10	8.10	Barre.	
12, . .	12.12	3.64	8.48	Barre.	
13, . .	12.50	3.71	8.89	Barre.	
14, . .	12.61	3.71	8.90	Barre.	
15, . .	13.04	4.19	8.85	Barre.	
16, . .	11.54	3.42	8.12	Barre.	
17, . .	12.71	3.82	8.89	New Braintree.	
18, . .	12.10	3.25	8.85	New Braintree.	
19, . .	10.76	2.13	8.63	New Braintree.	
20, . .	11.15	2.88	8.27	New Braintree.	
21, . .	12.18	3.55	8.63	New Braintree.	

ANALYSES OF MILK SENT ON FOR EXAMINATION — *Concluded.*

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
22, . .	13.30	3.65	9.65	New Braintree.	
23, . .	12.52	3.18	9.34	New Braintree.	
24, . .	12.59	3.68	8.91	New Braintree.	
25, . .	13.78	4.37	9.41	New Braintree.	
26, . .	13.39	4.13	9.26	New Braintree.	
27, . .	10.99	2.50	8.49	Westborough.	
28, . .	11.38	3.00	8.38	Westborough.	
29, . .	11.53	3.00	8.53	Westborough.	
30, . .	10.63	2.10	8.53	Westborough.	
31, . .	11.14	2.90	8.24	Westborough.	
32, . .	12.03	3.30	8.73	Westborough.	
33, . .	13.01	4.60	8.41	Westborough.	
34, . .	11.08	2.80	8.28	Westborough.	
35, . .	11.68	3.20	8.48	Westborough.	
36, . .	12.90	3.60	9.30	Barre Plains.	
37, . .	17.20	7.90	9.30	Norton.	
38, . .	12.83	4.06	8.77	Barre Plains.	
39, . .	12.14	3.66	8.48	Gilbertville.	
40, . .	12.25	3.61	8.64	Barre Plains.	

III.

Analyses of Water sent on for Examination.*

[Parts per million.]

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
1	.040	.112	3.00	3.25	176.00	56.00	-	Concord.
2	.036	.184	8.00	2.21	104.00	28.00	-	Northborough.
3	.056	.112	6.00	.79	116.00	32.00	-	Northborough.
4	.012	.028	2.00	1.82	104.00	86.00	-	Leverett.
5	.180	.234	6.00	.71	62.00	28.00	-	Barre.
6	.024	.104	25.00	9.71	330.00	134.00	-	Barre.
7	.068	.148	41.00	11.35	484.00	166.00	-	Barre.
8	.066	.194	14.00	3.51	156.00	44.00	-	Barre.
9	Trace.	.134	13.00	4.43	186.00	94.00	-	Weston.
10	.134	.144	5.00	.56	50.00	16.00	-	Barre.
11	.030	.060	5.00	.24	46.00	12.00	-	Barre.
12	.176	.100	104.00	7.14	380.00	168.00	-	Amherst.
13	.040	.088	8.00	1.56	108.00	60.00	None.	Amherst.
14	.056	.152	6.00	3.25	188.00	92.00	-	Amherst.
15	.048	.088	9.00	.16	84.00	28.00	-	Northfield.
16	.072	.096	20.80	4.57	160.00	64.00	-	Northfield.
17	.044	.096	13.00	2.86	164.00	68.00	-	Littleton.
18	.038	.044	4.00	.32	56.00	16.00	-	Holyoke.
19	.044	.036	4.00	-	80.00	24.00	-	Holyoke.
20	.072	.080	6.00	.16	60.00	36.00	-	Holyoke.
21	.084	.080	26.00	4.16	80.00	32.00	-	Westminster.
22	.060	.020	5.00	10.35	292.00	148.00	-	Springfield.
23	Trace.	Trace.	5.00	5.43	196.00	124.00	-	Springfield.
24	.016	.012	5.00	11.80	300.00	150.00	-	Springfield.
25	.022	.012	20.00	2.60	112.00	20.00	-	North Amherst.

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* Analysis of well water at the station is confined to chemical tests with reference to an excess of foreign matter from sinks, barns, etc.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
26	.008	.008	7.00	5.43	118.00	48.00	-	Leverett.
27	.024	.052	4.00	1.95	52.00	32.00	-	South Deerfield.
28	.024	.040	12.00	1.82	94.00	40.00	-	Weston.
29	.020	.036	10.00	1.82	-	-	-	Weston.
30	1.000	.920	24.00	7.02	308.00	104.00	-	South Deerfield.
31	.440	.208	10.00	3.12	140.00	68.00	-	Littleton.
32	.296	.184	14.00	1.69	130.00	40.00	-	Littleton.
33	.036	.136	6.00	.49	144.00	60.00	-	Littleton.
34	.160	.288	40.00	9.71	470.00	168.00	-	Lancaster.
35	.116	.128	8.00	2.21	78.00	46.00	-	New Braintree.
36	.012	.148	6.00	1.43	62.00	20.00	-	New Braintree.
37	.016	.180	12.00	2.21	96.00	12.00	-	Brockton.
38	.312	.360	14.00	3.64	176.00	74.00	-	East Lexington.
39	.120	.116	6.00	1.11	55.84	-	-	Lowell.
40	.020	.384	6.00	1.11	90.00	26.00	-	Springfield.
41	.128	.520	6.00	.95	76.00	20.00	-	Springfield.
42	.032	.168	4.00	1.95	80.00	26.00	-	Amherst.
43	.020	.108	5.00	.95	140.00	60.00	-	Hadley.
44	.024	.102	8.00	1.95	104.00	48.00	-	Amherst.
45	.024	.180	10.00	1.95	-	-	-	Amherst.
46	.008	.096	4.00	.95	72.00	24.00	None.	Amherst.
47	.004	.092	4.00	.95	80.00	28.00	-	Amherst.
48	.016	.086	7.00	2.21	112.00	52.00	-	Kendall Green.
49	.008	.060	6.00	1.95	112.00	52.00	-	Kendall Green.
50	.016	.144	4.00	1.95	104.00	28.00	-	Kendall Green.
51	.144	.264	8.00	-	100.00	20.00	-	Pelham.
52	.036	.204	6.00	-	-	-	-	Pelham.
53	.016	.192	4.00	-	-	-	-	Pelham.
54	.032	.068	22.00	-	-	-	-	Amherst.
55	.060	.096	4.00	4.86	76.00	24.00	-	Greenfield.
56	.300	-	12.00	-	-	-	-	Amherst.
57	.076	.084	96.00	-	-	-	-	Amherst.
58	.008	.068	40.00	-	-	-	-	Hadley.
59	.120	-	8.00	-	-	-	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
60	.028	.152	18.00	–	–	–	Present.	Amherst.
61	.036	.084	34.00	–	–	–	–	Amherst.
62	None.	.040	12.00	4.03	–	–	–	Amherst.
63	.076	.496	18.00	–	–	–	–	Amherst.
64	.024	.092	20.00	–	–	–	–	Amherst.
65	.028	.124	7.00	–	–	–	–	Amherst.
66	.024	.244	8.00	–	–	–	–	Amherst.
67	.072	.064	14.00	5.14	196.00	64.00	–	Springfield.
68	.040	.308	4.00	.48	160.00	60.00	–	Springfield.
69	None.	.092	6.00	–	–	–	–	Amherst.
70	.096	.112	8.00	–	–	–	–	Amherst.
71	.022	.242	8.00	–	–	–	–	South Deerfield.
72	.212	.108	6.00	5.29	–	–	–	Lawrence.
73	.088	.232	8.00	2.99	–	–	–	Lawrence.
74	.144	.184	12.00	2.99	–	–	–	Lawrence.
75	.024	.092	36.00	–	–	–	–	Amherst.
76	.010	.162	5.00	–	–	–	–	Pelham.
77	.004	.044	7.00	–	–	–	–	Medway.
78	None.	.072	48.00	4.29	–	–	–	Worcester.
79	Trace.	.082	16.00	–	–	–	–	Amherst.
80	1.840	–	16.00	–	–	–	–	Amherst.
81	.012	.448	4.00	.95	134.00	30.00	–	Pelham.
82	.040	.188	14.00	–	–	–	–	Amherst.
83	.016	.320	12.00	4.57	–	–	–	Amherst.
84	.008	.184	4.00	.95	–	–	–	Amherst.
85	.006	.040	7.00	1.69	46.00	4.00	–	Worcester.
86	.348	.128	6.00	1.27	29.00	8.00	–	Weston.
87	.032	.136	20.00	3.51	174.00	40.00	–	Dighton.
88	.108	.920	19.00	6.29	280.00	80.00	–	Templeton.
89	.076	.104	60.00	4.29	–	–	–	Amherst.
90	.120	.064	10.00	6.71	–	–	None.	Amherst.
91	.024	.068	7.00	–	–	–	–	North Amherst.
92	.044	.148	10.00	–	–	–	–	North Amherst.
93	.016	.164	15.00	–	–	–	–	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
94	.240	.120	10.00	-	-	-	-	South Deerfield.
95	.540	.440	16.00	-	-	-	-	Amherst.
96	.044	.080	12.00	-	-	-	-	Amherst.
97	.465	.210	4.00	-	-	-	-	Amherst.
98	.012	.176	22.00	5.43	272.00	36.00	-	Springfield.
99	.120	.056	18.00	-	-	-	-	Amherst.
100	Trace.	.072	27.00	-	-	-	-	Amherst.
101	Trace.	.100	86.00	10.00	-	-	-	Amherst.
102	.032	.120	21.00	6.43	-	-	-	Amherst.
103	.052	.061	14.00	2.60	-	-	-	Amherst.
104	.064	.042	10.00	1.43	132.00	60.00	-	Barre.
105	.072	.152	12.00	2.21	-	-	-	Methuen.
106	.016	.088	9.00	2.73	-	-	-	Amherst.
107	.004	.250	16.00	2.34	-	-	-	Amherst.
108	.380	.260	31.00	-	-	-	-	Amherst.
109	.460	-	19.00	-	-	-	-	Amherst.
110	.010	.248	4.00	-	96.00	24.00	-	Pelham.
111	Trace.	.070	20.00	5.29	-	-	-	Amherst.
112	None.	.110	13.00	-	-	-	-	Amherst.
113	.074	.106	37.00	10.30	-	-	-	Newburyport.
114	2.300	-	34.00	-	-	-	-	Amherst.
115	.024	.108	51.00	-	-	-	-	Amherst.
116	.044	.072	6.00	-	-	-	None.	North Amherst.
117	.072	.172	6.00	-	-	-	-	Petersham.
118	.030	.150	8.00	.95	-	-	-	Amherst.
119	.024	.178	5.00	.79	-	-	-	Coldbrook Springs.
120	.004	.044	12.00	-	-	-	None.	Amherst.
121	.016	.140	7.00	4.29	-	-	-	Amherst.
122	.012	.074	16.00	2.08	140.00	42.00	-	Amherst.
123	.048	.068	4.00	-	-	-	-	Leverett.
124	.008	.064	9.00	-	-	-	-	Amherst.
125	.004	.064	6.00	-	-	-	-	Amherst.
126	.008	.056	10.00	-	-	-	-	Berlin.
127	.046	.164	30.00	-	226.00	76.00	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
128	.120	.190	12.00	–	–	–	–	Amherst.
129	Trace.	.076	8.00	–	–	–	–	Amherst.
130	.020	.100	6.00	–	–	–	–	Petersham.
131	.108	.264	9.00	–	–	–	–	South Amherst.
132	Trace.	.253	5.00	–	–	–	–	Holyoke.
133	Trace.	.070	8.00	–	–	–	–	Amherst.
134	None.	.084	10.00	–	–	–	–	Amherst.
135	.060	.040	9.00	3.77	–	–	–	Westford.
136	.680	.350	9.00	5.57	–	–	–	Westford.
137	.016	.116	10.00	–	–	–	–	Amherst.
138	.200	.152	16.00	–	–	–	–	Amherst.
139	.076	.312	7.00	–	–	–	–	Northborough.
140	.084	.240	6.00	1.11	78.00	46.00	–	Pelham.
141	.016	.385	20.00	–	–	–	–	East Lexington.
142	.008	.054	9.00	2.99	–	–	–	Amherst.
143	None.	.020	7.00	.48	–	–	–	Amherst.
144	.080	.060	9.00	1.82	–	–	–	Amherst.
145	.014	.026	8.00	.48	–	–	Present.	North Brookfield.
146	.008	.088	12.00	–	–	–	–	Amherst.
147	Trace.	.352	8.00	–	–	–	Present.	Amherst.
148	.136	.224	18.00	6.86	–	–	–	Amherst.
149	.012	.120	10.00	4.03	160.00	58.00	–	North Hadley.
150	.008	.188	16.00	7.43	238.00	104.00	–	Williamsburg.
151	.068	.100	4.00	1.95	84.00	12.00	–	Westhampton.
152	.012	.240	4.00	.56	70.00	20.00	–	Amherst.
153	.622	–	166.00	–	–	–	–	North Hadley.
154	.128	.208	5.00	–	–	–	–	Monterey.
155	.040	.264	3.00	–	–	–	–	Amherst.
156	.024	.264	3.00	–	–	–	–	Amherst.
157	.012	.072	9.00	2.73	88.00	20.00	–	Chelmsford.
158	–	.200	5.00	–	74.00	20.00	–	Amherst.
159	.176	.192	5.00	.79	76.00	12.00	–	Amherst.
160	.072	.076	50.00	9.14	274.00	104.00	–	North Andover.
161	.040	.208	8.00	–	–	–	–	West Acton.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
162	.012	.180	4.00	–	60.00	22.00	–	Northfield.
163	.304	.184	6.00	–	60.00	22.00	–	Northfield.
164	.060	.096	4.00	4.86	76.00	24.00	–	Greenfield.
165	.040	.076	3.50	2.73	70.00	22.00	–	Greenfield.
166	.256	.072	18.00	3.51	166.00	32.00	–	Boston.
167	.036	.064	7.00	2.73	120.00	34.00	–	Boston.
168	.208	.176	5.00	.48	78.00	–	–	Amherst.
169	.208	.192	5.00	.48	80.00	20.00	–	Amherst.
170	.010	.214	4.00	.48	60.00	24.00	–	Amherst.
171	.028	.184	5.00	2.21	70.00	39.00	–	Greenfield.
172	.016	.144	4.00	3.90	104.00	64.00	–	Greenfield.
173	.036	.080	5.00	1.69	54.00	16.00	–	Greenfield.
174	.112	.080	7.00	–	–	–	–	Amherst.
175	.008	.120	11.00	3.25	124.00	38.00	–	Amherst.
176	None.	.092	18.00	5.14	246.00	96.00	–	Amherst.
177	Trace.	.252	8.00	4.29	128.00	76.00	–	Amherst.
178	.068	.160	26.00	–	–	–	–	North Amherst.
179	.064	.100	4.00	–	–	–	–	North Amherst.
180	–	–	–	4.03	138.00	90.00	–	Amherst.
181	.058	.088	21.00	9.43	270.00	112.00	–	Westford.
182	.050	.036	15.00	10.90	264.00	134.00	–	Westford.
183	.016	.248	5.00	.80	76.00	24.00	–	Amherst.
184	.012	.236	6.00	.80	76.00	20.00	–	Amherst.
185	.024	.120	6.00	4.29	384.00	60.00	–	Amherst.
186	.024	.032	8.00	2.73	96.00	36.00	–	Amherst.
187	.020	.108	28.00	2.21	184.00	48.00	–	Amherst.
188	.080	.220	12.00	1.69	84.00	28.00	–	South Framingham.
189	Trace.	.064	18.00	7.14	312.00	72.00	–	South Framingham.
190	.020	.128	8.00	2.73	68.00	28.00	–	South Framingham.
191	None.	.140	14.00	4.03	172.00	52.00	–	Amherst.
192	.016	.152	16.00	4.03	212.00	36.00	–	Amherst.
193	.012	.068	6.00	5.14	148.00	48.00	–	North Wilbraham.
194	.020	.136	32.00	6.29	260.00	92.00	–	North Amherst.
195	.148	.200	42.00	9.71	360.00	116.00	–	North Amherst.

ANALYSES OF WATER, ETC. — *Concluded.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
196	.100	.096	4.00	.48	48.00	24.00	-	Westford.
197	.048	.084	4.00	-	68.00	36.00	-	Amherst.
198	.036	.056	12.00	-	196.00	40.00	-	Amherst.
199	.012	.024	4.00	1.43	68.00	28.00	-	Amherst.
200	.156	.060	10.00	-	-	-	-	Amherst.

The analyses have been made according to Wanklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wanklyn and E. T. Chapman.)

Mr. Wanklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

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* One gallon equals 70,000 grains.

An examination of the previously stated analyses indicates that Nos. 2, 5, 7, 8, 14, 30, 31, 32, 34, 36, 37, 38, 40, 41, 42, 51, 52, 53, 56, 57, 59, 60, 63, 66, 68, 71, 72, 73, 74, 76, 80, 81, 82, 83, 84, 86, 88, 92, 93, 94, 95, 97, 98, 105, 107, 108, 109, 110, 114, 117, 118, 119, 127, 128, 131, 132, 136, 138, 139, 140, 141, 147, 148, 150, 153, 154, 155, 156, 158, 159, 161, 162, 163, 168, 170, 171, 177, 178, 183, 184, 188, 192 and 195 ought to be condemned as unfit for family use; while Nos. 1, 3, 6, 9, 10, 12, 15, 16, 17, 20, 33, 35, 39, 43, 44, 45, 46, 47, 48, 50, 55, 61, 64, 65, 67, 70, 75, 78, 79, 87, 89, 90, 96, 99, 101, 102, 104, 112, 113, 115, 121, 130, 137, 149, 151, 152, 160, 164, 166, 172, 174, 175, 179, 185, 187, 190, 191, 194, 196 and 200 must be considered suspicious.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One-half gallon is desirable for the analysis.

The examinations of water, carried on at the station by request, are for various reasons confined simply to a chemical examination regarding the presence or absence of foreign injurious matter due to infiltration from objectionable sources (sewage, etc.). The recognition of the presence and absence of objectionable bacterial growth is left to experts in that direction.

IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.

PREPARED BY C. S. CROCKER.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1895.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1894, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	70	1.91	–	–	–	–	58.98	45.94	51.06	–	–	–	–	–	–	6.69	–	.55	–	–	–	48.80	.70
Sulphate of potash,	24	2.55	–	–	–	–	51.28	21.36	34.99	–	–	–	–	–	–	4.46	–	1.50	–	45.72	–	–	.75
Sulphate of potash-magnesia,	19	4.77	–	–	–	–	29.48	16.96	24.06	–	–	–	–	–	–	6.25	2.57	–	–	44.25	–	2.60	1.41
Carbonate of potash,	1	26.88	–	–	–	–	–	–	18.48	–	–	–	–	–	–	–	–	19.52	–	–	–	–	.39
Phosphate of potash,	1	3.76	–	–	–	–	–	–	32.56	–	–	37.50	–	–	–	–	–	–	–	13.43	–	–	.92
Kainite,	4	3.20	–	–	–	–	16.48	12.51	13.54	–	–	–	–	–	–	18.97	1.15	9.80	–	20.25	–	33.25	2.13
Carnallite,	1	–	–	–	–	–	–	–	13.68	–	–	–	–	–	–	7.66	–	13.19	–	.56	–	41.56	–
Krugite,	1	4.82	–	–	–	–	–	–	8.42	–	–	–	–	–	–	5.27	12.45	8.79	–	31.94	–	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.82	17.30	–	36.10	–	–	5.73
Nitrate of potash,	4	1.30	–	14.58	11.60	12.71	45.62	44.76	45.27	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrate of soda,	25	1.47	–	16.01	14.28	14.70	–	–	–	–	–	–	–	–	–	35.50	–	–	–	–	–	.50	.50
Sulphate of ammonia,	26	1.05	–	21.68	19.59	22.16	–	–	–	–	–	–	–	–	–	–	–	–	–	60.00	–	–	–
Phosphate of ammonia,	1	6.05	–	–	–	10.37	–	–	–	–	–	43.86	–	–	–	–	–	–	–	12.46	–	–	.82
Sulphate of soda,	1	1.38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	59.43	–	–	–
Saltpetre waste,	12	2.54	–	3.30	.52	2.22	30.94	1.55	13.66	–	–	–	–	–	–	37.04	.75	.19	–	1.85	–	46.25	–

Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes,	392	10.80	-	-	-	-	10.80	1.20	5.34	5.58	.05	1.55	-	-	-	-	33.46	3.31	.96	-	-	-	14.12
Cotton-seed-hull ashes,	44	8.25	-	-	-	-	42.12	9.91	22.54	13.67	2.89	8.35	-	-	-	-	9.33	10.47	1.71	-	-	-	13.32
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	11	5.93	-	-	-	-	8.83	1.25	3.98	32.36	16.61	16.07	-	-	-	-	33.58	1.87	4.65	-	-	-	17.74
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypsum,	3	13.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.86	-	-	48.01	-	-	.59
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster,	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster,	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96.10	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	14	15.46	-	-	-	-	2.12	.02	1.15	3.16	.36	1.23	-	-	-	-	41.99	2.60	-	-	17.75	-	7.87

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc. —Concluded.																							
Marls (Massachusetts), ...	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia), ...	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia), . . .	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia), ...	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl, ...	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina), ...	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called), ...	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano, ...	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas, ...	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida, ...	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida, ...	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano, ...	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla), ...	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27

Mona Island guano,	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45
South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	29	2.09	-	-	-	-	-	-	-	38.97	6.95	26.15	-	-	-	-	30.40	-	7.56	-	-	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	3	3.35	-	-	-	-	.52	.32	.42	19.45	18.40	18.75	-	-	-	-	52.85	-	-	-	2.51	-	5.90
Dissolved bone-black,	4	11.14	47.50	-	-	-	-	-	-	17.54	15.35	16.04	14.56	1.12	.36	-	-	-	-	-	-	-	3.46
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	16	12.23	6.37	13.55	8.10	10.51	-	-	-	6.23	1.53	2.05	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble' Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances—Continued.																							
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	9	12.90	24.10	10.20	.96	4.88	3.50	.06	1.46	.67	.05	.35	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	156	7.00	53.03	4.70	1.57	3.96	-	-	-	32.52	15.16	22.29	.38	8.24	13.62	-	-	-	-	-	-	-	1.09

Meat and bone,	1	5.70	-	-	-	4.01	-	-	-	-	-	21.88	.26	8.32	13.30	-	-	-	-	-	-	-	-
Tankage,	6	9.84	-	9.16	6.94	8.14	-	-	-	12.60	4.03	10.20	-	-	-	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	67	12.45	21.50	11.40	5.97	7.45	-	-	-	15.91	5.50	8.46	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water,	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton seed meal,	28	6.53	5.78	7.70	4.02	6.67	2.38	.48	1.71	3.36	.73	1.59	-	-	-	-	-	-	-	-	-	-	.33
Rotten brewers' grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.44	.60	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	1	6.44	60.60	9.33	.96	3.45	1.62	.66	1.20	1.80	.26	.73	-	-	-	-	-	-	-	-	-	-	45.00
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances—Concluded.																							
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-		1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60

Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	21	62.19	13.75	2.54	.26	.86	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat,	10	61.50	8.20	1.40	.41	.85	-	-	.18	-	-	.08	-	-	-	-	.52	.72	2.14	-	-	-	2.20
Peat,	1	10.73	17.26	-	-	1.78	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	6	1.87	77.10	1.05	.09	.41	1.83	.21	.64	2.10	.19	1.06	-	-	-	-	3.11	-	7.19	-	-	-	67.25
Boiler soot,	1	18.80	-	-	-	-	-	-	.26	-	-	.70	-	-	-	-	58.28	1.46	1.46	-	32.95	-	3.09
IV. Animal Excrement, etc.																							
Barn-yard manure,	64	66.62	-	1.36	.21	.54	1.40	.13	.54	.75	.10	.40	-	-	-	-	.30	.19	-	-	-	-	8.48
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	1	64.88	-	-	-	.686	-	-	.525	-	-	.425	-	-	-	-	-	-	-	-	-	-	.404
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen manure, dry,	1	8.35	-	-	-	2.13	-	-	9.94	-	-	2.02	-	-	-	-	2.22	.62	-	-	-	-	34.64
Hen-house refuse,	1	3.43	-	-	-	.98	-	-	.60	-	-	1.28	-	-	-	-	-	-	-	-	-	-	-

V. COMPILATION OF ANALYSES OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

1868-1895.

PREPARED BY C. S. CROCKER.

A. ANALYSES OF FODDER ARTICLES.

B. ANALYSES OF FODDER ARTICLES WITH REFERENCE TO FERTILIZING INGREDIENTS.

C. ANALYSES OF FRUIT.

D. ANALYSES OF SUGAR-PRODUCING PLANTS.

E. DAIRY PRODUCTS.

F. INSECTICIDES.

A. *Analyses of Fodder Articles.*

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders.																	
Fodder corn,	31	31.47	10.33	**20.29**	17.19	6.05	**9.86**	6.10	1.42	**2.44**	63.13	42.02	**56.51**	31.53	18.27	**25.29**	5.90
Fodder corn ensilage,	38	37.43	13.12	**21.70**	16.72	5.98	**8.66**	6.49	1.82	**3.80**	65.69	42.99	**54.28**	38.92	17.67	**27.73**	5.33
Corn and soja-bean ensilage,	3	28.97	19.67	**23.55**	15.27	7.91	**10.53**	5.35	3.02	**4.04**	52.24	40.50	**43.47**	37.84	26.62	**31.15**	10.81
Oat and pea ensilage,	1	-	-	**61.98**	-	-	**13.72**	-	-	**3.94**	-	-	**41.81**	-	-	**31.34**	9.19
Millet and bean ensilage,	1	-	-	**24.18**	-	-	**10.64**	-	-	**5.40**	-	-	**42.44**	-	-	**31.23**	10.29
Ensilage of millet and white soja bean,	1	-	-	**22.59**	-	-	**11.25**	-	-	**3.71**	-	-	**42.99**	-	-	**33.14**	8.91
Ensilage of *Panicum miliaceum*,	1	-	-	**21.99**	-	-	**7.46**	-	-	**3.34**	-	-	**49.08**	-	-	**31.80**	8.32
Ensilage of *Panicum crus-galli*,	1	-	-	**23.25**	-	-	**7.89**	-	-	**2.74**	-	-	**43.87**	-	-	**36.93**	8.57
Sorghum,	6	23.18	12.38	**17.41**	11.84	7.46	**8.74**	2.00	1.21	**1.55**	64.93	47.65	**56.15**	29.27	22.00	**26.73**	6.83
Common millet,	9	42.29	21.32	**35.42**	12.16	5.43	**7.50**	3.99	2.09	**2.74**	58.61	46.39	**53.93**	33.98	24.88	**30.99**	4.84
Japanese millet (white head),	3	26.24	20.95	**24.76**	10.98	7.26	**8.72**	2.64	1.94	**2.33**	50.87	46.71	**49.60**	38.90	30.12	**34.47**	4.88
Japanese millet (red head),	6	33.83	22.66	**27.33**	7.99	4.92	**6.90**	2.45	1.58	**2.01**	60.83	50.11	**52.91**	35.29	25.21	**32.10**	6.08
Panicum miliaceum,	1	-	-	**30.63**	-	-	**5.96**	-	-	**3.84**	-	-	**58.82**	-	-	**26.85**	5.53
Panicum crus-galli,	2	29.28	24.89	**27.08**	11.45	7.98	**9.71**	2.79	2.20	**2.49**	57.88	46.50	**52.20**	29.51	26.31	**27.91**	7.69
White kibi,	2	24.26	22.85	**23.56**	15.14	10.79	**12.97**	1.61	1.50	**1.56**	53.66	52.30	**47.29**	35.29	25.21	**32.10**	6.08
Mochi millet,	3	42.29	30.07	**37.42**	11.90	6.11	**9.94**	1.94	1.74	**1.81**	67.08	49.06	**55.69**	29.80	20.01	**25.56**	7.00
Green oats,	6	55.69	15.51	**25.97**	20.47	7.05	**13.91**	3.95	2.02	**2.89**	50.69	40.42	**44.91**	33.12	25.20	**30.04**	8.25

Green rye,	2	37.89	98.05	27.97	9.64	5.38	7.51	2.46	1.86	2.16	65.37	40.20	52.79	42.17	21.52	31.84	5.70
Green barley,	1	-	-	20.89	-	-	13.16	-	-	2.91	-	-	37.48	-	-	37.72	8.73
Timothy (*Phleum pratense*),	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33
Hungarian grass (*Setaria Italica* Beauv.),	2	25.93	25.69	25.81	9.39	9.38	9.38	2.43	1.01	1.72	57.80	48.01	52.92	31.23	24.66	27.94	8.04
Vetch and oats (one part vetch and four parts oats),	1	-	-	20.84	-	-	13.27	-	-	3.90	-	-	43.69	-	-	30.34	8.80
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	18.97	10.76	8.83	10.06	2.74	2.29	2.53	49.85	40.10	44.75	35.81	30.77	33.59	9.07
Vetch and oats (equal parts of each),	1	-	-	17.98	-	-	16.77	-	-	2.79	-	-	41.33	-	-	29.80	9.31
Barley and peas,	1	-	-	16.09	-	-	13.40	-	-	3.00	-	-	41.79	-	-	33.49	8.32
Oats and peas,	2	18.41	13.68	16.04	16.01	14.17	15.09	3.40	2.29	2.84	48.14	40.56	44.36	32.20	26.66	29.43	8.28
Horse bean (*Vicia faba* L.),	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75
Flat pea (*Lathyrus sylvestris*),	2	21.38	21.20	21.29	30.65	27.26	28.95	5.00	3.29	4.14	35.06	31.83	33.46	28.27	20.38	24.32	9.13
Soja bean (*Soja hispida*),	14	36.36	18.54	24.48	22.19	13.71	17.26	8.98	2.71	4.57	47.89	34.24	41.73	31.89	21.67	26.47	9.97
Soja bean (early white),	4	34.02	20.49	28.24	20.13	13.81	16.48	2.97	2.16	2.71	49.94	37.23	45.27	27.12	17.28	22.76	12.78
Soja bean (early green),	1	-	-	30.16	-	-	19.35	-	-	3.87	-	-	40.30	-	-	23.51	12.97
Soja bean (early black),	1	-	-	17.79	-	-	16.18	-	-	3.38	-	-	42.52	-	-	25.06	12.86
Soja bean (medium black),	1	-	-	23.13	-	-	21.67	-	-	6.76	-	-	37.18	-	-	21.73	12.66
Soja bean (late),	4	31.89	20.22	26.02	27.49	18.56	22.84	3.34	2.25	2.76	44.84	37.97	39.70	23.62	16.47	21.09	13.61
Bokhara clover (*Melilotus alba* Desr.),	3	24.14	19.01	21.22	23.37	17.18	19.72	3.51	2.76	3.04	38.43	37.02	37.89	33.99	24.43	29.46	9.89
Kidney vetch (*Anthyllis vulneraria*),	1	-	-	19.15	-	-	18.43	-	-	3.51	-	-	49.84	-	-	14.94	13.28
Serradella (*Ornithopus sativus* Brot.),	3	19.42	15.40	17.59	17.75	12.17	15.01	2.65	2.09	2.41	46.41	35.45	41.51	38.76	26.21	30.08	10.99
Prickly comfrey (*Symphytum officinale*),	1	-	-	13.21	-	-	17.49	-	-	2.06	-	-	48.30	-	-	11.03	21.12
White lupine (*Lupinus albus*),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03

A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders — Concluded.																	
Yellow lupine (*Lupinus lutens*),	1	–	–	13.95	–	–	17.84	–	–	1.87	–	–	42.05	–	–	27.10	11.14
Spanish moss (*Tillandsia usneoides*),	1	–	–	39.20	–	–	4.45	–	–	2.54	–	–	57.73	–	–	32.61	2.67
II. Hay and Dry Coarse Fodders.																	
English hay (mixed hay),	56	91.94	66.59	85.53	14.19	6.19	9.46	4.10	1.56	2.85	54.72	43.63	50.29	35.55	26.41	31.05	6.35
Rowen of mixed hays,	15	91.76	75.55	82.74	14.70	11.63	12.72	5.03	2.60	3.62	53.52	41.92	49.68	31.50	24.25	26.77	7.21
Timothy hay,	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.34	36.59	29.21	32.90	4.88
Red-top hay (*Agrostis vulgaris* With.)	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.58	8.35
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	91.17	11.29	7.57	9.43	3.56	2.40	2.91	47.34	43.50	46.16	35.79	34.12	34.89	7.05
Meadow fescue (*Festuca pratensis* Huds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13
Perennial rye-grass (*Lolium perenne* L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14
Italian rye-grass (*Lolium Italicum* A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52
Hungarian grass,	1	–	–	92.55	–	–	9.45	–	–	2.22	–	–	50.64	–	–	31.96	5.73
Barn-yard grass (*Panicum crus-galli* L.),	1	–	–	93.35	–	–	15.27	–	–	1.95	–	–	30.24	–	–	32.72	10.02
Hay of black grass,	1	–	–	91.25	–	–	6.72	–	–	3.37	–	–	49.47	–	–	31.41	9.03
Low meadow hay,	1	–	–	91.99	–	–	9.51	–	–	1.88	–	–	46.27	–	–	35.59	6.75
Salt hay,	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.65	2.95	60.15	60.14	60.14	27.84	27.82	27.83	5.02

Millet,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08
Oats in bloom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.06	6.41
Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08
Oats, ripe,	1	-	-	91.30	-	-	6.05	-	-	2.61	-	-	48.92	-	-	36.31	6.11
Winter rye in bloom,	1	-	-	91.45	-	-	10.66	-	-	2.57	-	-	47.40	-	-	32.97	6.40
Barley in milk,	1	-	-	89.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95
Common buckwheat,	1	-	-	91.50	-	-	17.90	-	-	3.04	-	-	45.08	-	-	19.35	14.63
Silver-hull buckwheat,	1	-	-	91.09	-	-	12.22	-	-	2.55	-	-	47.99	-	-	27.07	10.17
Japanese buckwheat,	1	-	-	94.29	-	-	10.80	-	-	2.22	-	-	38.60	-	-	36.02	12.36
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14
Corn stover,	28	94.44	75.00	88.33	12.15	5.46	7.37	2.63	1.08	1.38	63.05	44.65	50.52	38.83	20.93	34.90	5.83
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11
Sand lucerne (*Medicago media* Pers.),	1	-	-	91.20	-	-	16.26	-	-	2.59	-	-	50.31	-	-	21.27	9.57
Bokhara clover (*Melilotus alba* Desr.),	5	93.64	91.50	92.09	23.37	11.81	17.18	4.79	1.85	3.15	51.36	37.02	40.79	33.05	28.08	29.90	8.93
Blue melilot (*Melilotus cærulea* Desr.),	1	-	-	91.78	-	-	13.81	-	-	1.67	-	-	42.48	-	-	27.17	14.87
Sainfoin (*Onobrychis sativa*),	3	91.28	87.83	90.11	18.11	15.95	17.25	4.49	2.78	3.36	50.55	42.32	46.66	26.95	22.49	24.02	8.71
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32
Hairy lotus (*Lotus villosus* Thuill.),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27
Summer rape (*Brassica napus*),	1	-	-	88.87	-	-	14.43	-	-	3.79	-	-	45.38	-	-	18.15	18.25

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN—												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
II. Hay and Dry Coarse Fodders—Concluded.																	
Winter rape (*Brassica napus*),	1	-	-	89.85	-	-	15.16	-	-	3.06	-	-	47.08	-	-	12.26	22.44
Dwarf Essex rape (*Brassica napus*),	1	-	-	92.29	-	-	12.86	-	-	3.80	-	-	42.27	-	-	18.96	16.11
Soja bean,	4	93.88	79.91	87.78	19.06	14.89	16.23	8.33	2.55	4.72	51.28	41.09	46.70	27.73	20.76	24.02	8.33
Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29
Small pea (*Lathyrus sativus*),	1	-	-	94.20	-	-	16.57	-	-	1.49	-	-	42.76	-	-	32.88	6.30
Flat pea (*Lathyrus sylvestris*),	1	-	-	91.10	-	-	24.04	-	-	1.78	-	-	33.03	-	-	31.76	9.39
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.22	44.49	48.18	25.92	24.37	25.15	7.09
Hairy vetch (*Vicia villosa* Roth.),	1	-	-	92.56	-	-	19.58	-	-	1.22	-	-	38.95	-	-	31.88	8.37
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24
Scotch tares,	1	-	-	84.20	-	-	22.00	-	-	1.89	-	-	31.46	-	-	30.89	13.76
Vetch and oats,	3	94.22	83.33	88.35	13.51	7.70	9.64	3.45	2.53	3.11	49.95	41.51	46.83	36.22	30.15	32.70	7.72
Vetch and oats (equal parts of each),	2	90.65	90.64	90.64	18.88	15.16	17.02	3.13	2.63	2.88	42.24	38.57	40.41	31.28	29.83	30.55	9.14
Vetch and barley,	2	91.51	90.76	91.13	14.44	13.36	13.90	2.56	2.12	2.34	46.55	43.70	45.13	32.58	32.25	32.41	6.22
Vetch, oats and horse bean,	1	-	-	89.81	-	-	18.93	-	-	2.70	-	-	37.94	-	-	30.07	10.36
Horse-bean straw,	1	-	-	90.85	-	-	9.69	-	-	1.51	-	-	37.77	-	-	41.44	9.59
Soja-bean straw,	3	92.37	86.03	88.57	5.73	5.34	5.48	3.49	1.17	2.15	43.72	41.02	42.81	46.51	36.80	42.38	7.18
White daisy (*Chrysanthemum leucanthemum* L.),	1	-	-	90.35	-	-	7.68	-	-	2.32	-	-	46.86	-	-	36.09	7.05

Dry carrot tops,	1	-	-	90.24	-	-	20.12	-	-	2.01	-	-	50.39	-	-	13.61	13.87
Wheat straw,	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.46	-	-	35.91	4.80
Barley straw,	2	91.41	88.56	89.98	9.24	6.21	7.72	3.38	2.49	2.93	48.23	46.52	46.89	39.84	33.85	36.84	5.62
Japanese millet (white head),	1	-	-	91.48	-	-	7.67	-	-	2.41	-	-	49.87	-	-	34.99	5.06
Japanese millet (red head),	1	-	-	91.13	-	-	5.76	-	-	1.70	-	-	49.66	-	-	39.52	3.36
Millet straw,	1	-	-	86.55	-	-	4.95	-	-	1.43	-	-	44.96	-	-	41.82	6.84
Straw (*Panicum crus-galli*),	1	-	-	87.35	-	-	6.10	-	-	2.44	-	-	50.20	-	-	35.90	5.36
Straw (*P. miliaceum*),	1	-	-	87.83	-	-	3.94	-	-	3.01	-	-	44.72	-	-	42.16	6.17
Straw (*P. Italicum*),	1	-	-	80.28	-	-	4.17	-	-	1.59	-	-	46.39	-	-	41.54	6.31
III. Roots, Bulbs, Tubers, etc.																	
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58
Beets, sugar,	12	19.53	9.87	14.60	17.44	7.32	11.18	.83	.58	.67	81.50	61.93	75.62	9.69	4.82	6.55	5.98
Beets, yellow fodder,	4	15.01	9.40	11.46	13.96	9.29	11.69	2.02	.84	1.39	75.22	61.90	69.33	9.66	7.26	8.14	9.45
Mangolds,	4	13.08	11.49	12.06	12.84	7.04	9.54	1.14	.73	.97	73.38	70.32	71.03	9.98	7.08	8.45	10.01
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75
Turnips,	5	12.80	8.22	10.38	11.39	9.67	10.57	2.23	1.42	1.79	70.62	65.91	67.51	13.34	10.12	11.68	8.45
Carrots,	5	12.52	9.95	10.98	9.75	7.29	8.76	3.94	1.41	2.09	73.96	67.24	71.63	10.76	7.55	9.08	8.44
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	7.67	7.43
Potatoes,	13	21.95	13.91	19.01	13.56	6.24	10.05	.83	.17	.49	87.56	78.80	*81.69	3.55	1.91	2.64	5.13
Artichokes,	1	-	-	22.51	-	-	12.82	-	-	.95	-	-	77.26	-	-	4.18	4.79
Japanese radish (*merinia*),	1	-	-	6.74	-	-	7.47	-	-	1.05	-	-	70.89	-	-	10.27	10.32
Japanese radish (*niyas hige*),	1	-	-	7.42	-	-	6.51	-	-	.96	-	-	72.87	-	-	9.79	9.87

* Starch (six determinations), 69.95 per cent.

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —													
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
IV. Grains, Seeds, Fruits, etc.																	
Corn kernels,	29	91.98	65.50	89.43	15.02	8.49	12.18	9.43	4.25	5.42	83.98	71.06	78.49	3.38	1.03	2.12	1.69
Sweet corn kernels,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Wheat kernels,	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.26	-	-	2.42	2.18
Oat kernels,	1	-	-	86.84	-	-	14.44	-	-	6.83	-	-	66.21	-	-	9.03	3.49
Broom-corn seed,	1	-	-	85.90	-	-	11.21	-	-	4.05	-	-	74.05	-	-	8.34	2.35
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84
Horse beans,	1	-	-	89.72	-	-	30.03	-	-	1.11	-	-	56.48	-	-	8.11	4.27
Red adzinki beans,	2	85.18	83.10	84.14	25.14	23.75	24.45	.88	.76	.82	66.48	65.41	65.95	4.68	4.50	4.59	4.19
Saddle beans,	1	-	-	87.62	-	-	15.12	-	-	16.58	-	-	57.34	-	-	4.75	6.21
Daidzu beans,	1	-	-	88.47	-	-	38.99	-	-	18.59	-	-	30.41	-	-	4.97	7.04
Millet seed,	3	87.32	86.11	86.65	14.60	11.76	13.24	4.94	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.88	3.00
Chestnuts,	1	-	-	55.14	-	-	13.32	-	-	14.46	-	-	67.05	-	-	2.45	2.72
Cranberries,	1	-	-	10.59	-	-	4.40	-	-	5.61	-	-	76.37	-	-	11.63	1.99
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08
V. Flour and Meal.																	
Corn meal,	36	89.95	79.81	86.24	16.08	9.73	11.04	5.14	3.10	3.86	83.61	73.20	81.38	3.60	1.20	2.15	1.57
Corn and cob meal,	37	94.00	80.89	89.47	15.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.62	10.41	5.63	7.54	1.64

Cooked feed (oats and corn),	1	-	-	94.45	-	-	14.75	-	-	5.34	-	-	67.14	-	-	8.73	4.04
Hominy meal,	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.72	33.77	31.36	32.93	1.21
Ground oats,	2	91.11	90.29	90.70	13.20	11.93	12.56	4.52	3.51	4.01	-	-	70.21	-	-	9.29	3.93
Ground barley,	5	89.09	82.59	86.91	14.93	9.99	12.95	2.57	1.69	2.18	78.25	74.47	76.63	8.03	4.10	6.47	2.77
Broom-corn meal,	1	-	-	86.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43
Pea meal,	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94
Peanut meal,	1	-	-	92.00	-	-	53.26	-	-	11.69	-	-	27.00	-	-	3.76	4.29
Bean meal,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Soja-bean meal,	1	-	-	89.20	-	-	41.18	-	-	18.17	-	-	30.60	-	-	5.01	5.04
Millet meal (*Panicum Italicum*),	1	-	-	89.38	-	-	35.12	-	-	17.35	-	-	38.95	-	-	3.86	4.72
VI. By-products and Refuse.																	
Linseed cake, old process,	8	92.52	88.50	90.32	39.97	33.98	36.65	9.87	6.24	7.30	44.72	37.76	40.51	9.69	8.04	8.62	6.92
Linseed cake, new process,	7	94.94	88.17	91.65	41.02	35.03	39.38	4.08	2.17	3.24	46.49	40.54	41.74	10.31	8.59	9.28	6.36
Cotton-seed meal,	32	94.42	88.81	92.11	51.79	36.54	45.24	14.72	8.41	11.68	35.84	20.22	28.11	10.83	5.08	7.44	7.51
Cotton-seed bran,	1	-	-	88.90	-	-	11.82	-	-	3.17	-	-	50.34	-	-	31.09	3.58
Wheat bran,	43	92.58	86.30	89.35	20.54	15.67	17.86	6.36	2.80	5.00	62.83	51.77	58.34	14.26	7.49	10.98	7.82
Spring-wheat bran,	3	91.03	87.26	88.67	19.54	16.19	17.78	5.46	5.37	5.41	59.39	56.54	57.50	13.75	10.84	12.02	7.29
Winter-wheat bran,	2	87.76	86.94	87.35	17.04	16.24	16.64	4.57	3.43	4.00	62.83	59.83	61.33	12.74	9.32	11.03	7.00
Wheat middlings,	7	90.75	87.57	89.76	20.07	15.13	17.19	6.46	3.19	5.40	74.30	58.03	62.46	11.21	1.40	8.46	6.49
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30
Rye middlings,	1	-	-	87.46	-	-	13.15	-	-	5.61	-	-	73.52	-	-	3.70	4.02
Pea bran,	1	-	-	92.86	-	-	10.31	-	-	1.16	-	-	39.04	-	-	46.16	3.33
Buckwheat middlings,	1	-	-	88.49	-	-	25.49	-	-	7.53	-	-	66.36	-	-	5.16	5.44

A. *Analyses of Fodder Articles* — Concluded.

NAME.	Analyses.	DRY MATTER.			ONE HUNDRED PARTS OF DRY MATTER CONTAIN —												
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
VI. By-products and Refuse — Concluded.																	
Gluten meal,	38	93.67	68.32	**90.98**	39.28	25.75	**29.99**	14.47	3.92	**9.13**	66.26	48.26	**56.34**	10.06	.41	**3.59**	.95
Gluten meal (Chicago),	3	92.71	88.89	**90.76**	37.09	30.19	**33.53**	9.22	4.60	**6.80**	57.97	56.64	**57.55**	1.73	.73	**1.23**	.89
Gluten meal (King),	2	93.35	92.22	**92.78**	38.57	36.19	**37.38**	21.44	19.68	**20.56**	38.84	38.56	**38.74**	1.62	1.41	**1.51**	1.84
Gluten feed (Buffalo),	15	93.67	90.61	**91.93**	31.05	21.11	**25.01**	14.76	9.18	**12.90**	62.79	48.80	**53.64**	10.06	5.43	**7.42**	1.03
Gluten feed (Pope),	1	-	-	**86.02**	-	-	**38.68**	-	-	**16.34**	-	-	**42.43**	-	-	**1.80**	.75
Gluten feed (Peoria),	2	92.93	92.50	**92.71**	22.71	21.35	**22.03**	14.33	13.62	**13.97**	55.27	53.50	**54.39**	8.86	8.30	**8.58**	1.03
Maize feed (Chicago),	4	91.40	90.25	**91.41**	29.40	21.33	**25.87**	7.90	6.15	**7.06**	62.12	53.85	**57.53**	9.65	7.93	**8.70**	.84
Starch feed (Pope),	1	-	-	**94.52**	-	-	**11.28**	-	-	**11.30**	-	-	**61.31**	-	-	**15.21**	.90
Dry distillery feed (Atlas mills),	1	-	-	**88.75**	-	-	**37.30**	-	-	**15.28**	-	-	**35.07**	-	-	**11.94**	.41
Glucose feed (Richardson),	1	-	-	**93.68**	-	-	**23.12**	-	-	**11.67**	-	-	**52.41**	-	-	**11.67**	1.13
Corn-germ meal,	1	-	-	**90.65**	-	-	**28.26**	-	-	**11.82**	-	-	**42.49**	-	-	**9.18**	8.25
Corn-germ feed,	1	-	-	**92.45**	-	-	**10.81**	-	-	**12.17**	-	-	**62.10**	-	-	**14.05**	.87
Corn screenings,	1	-	-	**88.98**	-	-	**8.29**	-	-	**4.48**	-	-	**81.57**	-	-	**3.27**	2.39
Proteina (mixed feed),	4	93.20	89.94	**91.61**	27.23	20.53	**23.67**	8.24	5.01	**7.20**	61.53	51.11	**55.55**	12.33	10.18	**10.92**	2.66
Excelsior feed,	1	-	-	**92.92**	-	-	**6.75**	-	-	**5.42**	-	-	**65.75**	-	-	**14.65**	4.43
Corn screenings,	1	-	-	**88.98**	-	-	**8.29**	-	-	**4.48**	-	-	**81.57**	-	-	**3.27**	2.39
Oat feed,	4	90.66	90.53	**92.20**	15.60	11.02	**13.15**	8.23	3.95	**5.32**	68.08	57.28	**63.88**	17.73	8.06	**11.52**	6.13
Rye feed,	2	91.77	90.37	**91.05**	16.62	13.65	**15.09**	3.04	2.79	**2.91**	77.51	73.38	**75.44**	3.62	3.52	**3.58**	2.98

Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Cocoanut meal,	1	-	-	90.67	-	-	22.61	-	-	12.88	-	-	40.03	-	-	18.83	5.68
Louisiana rice bran,	1	-	-	89.75	-	-	9.82	-	-	9.66	-	-	55.07	-	-	14.66	10.59
Peanut feed,	2	90.92	89.08	89.99	10.31	9.54	9.92	7.61	4.49	6.05	19.55	17.35	18.46	62.82	62.48	62.65	2.92
Peanut husks,	1	-	-	87.02	-	-	5.74	-	-	1.90	-	-	15.09	-	-	75.91	1.36
Bakery refuse,	1	-	-	86.66	-	-	9.23	-	-	6.36	-	-	72.34	-	-	.43	11.64
Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90
Oat meal and barley refuse,	1	-	-	92.24	-	-	7.45	-	-	3.80	-	-	62.61	-	-	22.30	3.84
Glucose refuse,	1	-	-	93.29	-	-	21.06	-	-	10.55	-	-	62.42	-	-	4.77	1.20
Spent brewers' grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53
Malt sprouts,	1	-	-	84.63	-	-	27.17	-	-	3.85	-	-	47.92	-	-	14.75	6.31
Damaged wheat,	1	-	-	86.90	-	-	16.26	-	-	2.51	-	-	75.85	-	-	3.11	2.31
Cocoa dust from cocoa manufactory,	1	-	-	92.90	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88
Refuse from cows' manger,	4	85.73	64.81	77.44	6.63	4.31	5.01	1.09	.74	.98	45.46	42.12	43.74	46.91	38.72	43.94	6.33
Refuse from cows' manger (ensilage),	6	39.89	21.73	27.07	11.56	8.64	8.38	2.04	1.30	1.48	44.96	41.67	45.97	40.37	33.98	34.57	9.60
Cotton hulls,	3	91.85	88.55	89.98	5.36	4.10	4.79	4.27	1.79	2.81	46.75	38.59	43.34	51.40	40.24	46.08	2.98
Apple pomace,	3	21.78	12.49	17.16	7.73	5.75	6.81	5.93	3.17	4.49	72.93	63.29	69.49	21.67	13.15	17.13	2.08
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21
Sugar beet pulp, from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04
Corn cobs,	6	94.05	90.00	92.35	4.15	1.46	2.91	.77	.38	.56	63.62	58.78	61.21	37.84	31.36	33.96	1.36
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients.*

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$1 93
Fodder corn ensilage,	7	80.19	.422	-	.385	.050	.100	.090	.020	.129	.255	-
Corn and soja-bean ensilage,	1	71.03	.790	-	.444	-	-	-	-	.420	-	3 67
Ensilage of millet and white soja bean,	1	77.41	.400	-	.540	-	-	-	-	.130	-	-
Ensilage of *Panicum miliaceum*,	1	78.01	.260	-	.430	-	-	-	-	.110	.500	1 49
Ensilage of *Panicum crus-galli*,	1	76 75	.294	-	.621	-	-	-	-	.133	-	1 84
Sorghum,	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 16
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	2 07
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 76
Millet (*Panicum crus-galli*),	1	75.11	.455	-	.494	-	-	-	-	.109	-	2 24
Green oats,	3	83.36	.489	1 31	.381	.217	.154	.134	.018	.130	.496	2 26
Green rye,	2	72.03	.302	-	.636	-	-	-	-	.117	-	1 87
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 78
Horse bean,	1	74.71	.675	-	.346	.028	.346	.157	.050	.083	.514	2 85
Soja bean,	1	73.20	.292	-	.531	-	-	-	-	.151	-	1 76
Soja bean (early white),	1	66.56	.943	-	.905	-	-	-	-	.214	-	4 51

Soja bean (early green),	1	69.84	.835	-	.707	-	-	-	-	.201	-	3 90
Soja bean (medium black),	1	76.87	.803	-	.566	-	-	-	-	.175	-	3 61
Soja bean (late),	1	79.78	.600	-	.677	-	-	-	-	.130	-	2 98
Kidney vetch,	1	80.85	.563	-	.346	.218	.907	.055	.027	.085	.155	2 46
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 39
Prickley comfrey,	1	86.79	.370	-	.759	.122	.309	.041	.058	.115	-	2 24
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	2 04
Common buckwheat,	1	84.65	.440	-	.538	-	-	-	-	.089	.577	2 22
Flat pea (*Lathyrus sylvestris*),	1	78.62	1.049	-	.449	-	.302	.088	.056	.140	.247	4 30
Hungarian grass,	1	74.31	.386	-	.549	-	-	-	-	.159	-	2 11
White lupine,	1	85.35	.440	-	.253	.100	.450	.107	.025	.051	.131	1 87
Yellow lupine,	1	85.05	.398	-	.441	.086	.288	.049	.008	.092	.161	1 49
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 30
II. Hay and Dry Coarse Fodders.												
English hay,	10	11.94	1.294	6.34	1.528	.110	.344	.240	.021	.286	.911	6 49
Rowen,	13	18.53	1.629	9.57	1.499	.140	.640	.280	.034	.442	1.840	-
Timothy hay,	3	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	6 28
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	5 51
Kentucky blue-grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	6 91

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* The valuation is based on the following prices per pound of the essential fertilizing ingredients: nitrogen, 17½ cents; potassium oxide, 5½ cents; phosphoric acid, 5 cents.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	$7 07
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	6 18
Perennial rye-grass,	2	9.13	1.227	6.79	1.555	.307	.642	.337	.044	.559	2.262	6 56
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.556	2.598	6 13
Salt hay,	1	5.36	1.180	-	.718	.017	.371	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1.033	5 62
Common buckwheat,	1	8.50	2.620	-	3.208	-	-	-	-	.532	3.436	13 04
Silver-hull buckwheat,	1	8.91	1.780	-	2.380	-	2.290	.526	.059	.860	.462	9 71
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	10 21
Fodder corn,	7	7.85	1.763	4.91	.889	175	.605	.500	.075	.542	1.270	7 69
Corn stover,	17	9.33	1.038	3.74	1.375	.112	.622	.384	.068	.288	1.782	5 43
Teosinte,	1	6.06	1.460	6.53	3.696	.109	1.597	.458	.021	.546	.315	9 72
Summer rape,	1	11.13	2.053	-	4.670	.994	3.691	.522	.031	.572	.709	12 89
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.420	1.360	6 83
Mammoth red clover,	3	11.41	2.231	8.72	1.223	.369	3.141	.613	.111	.546	.779	9 98

Medium red clover,	2	7.91	**2.184**	8.36	**2.286**	.210	1.689	.402	.099	**.447**	.919	10 61
Alsike clover,	6	9.94	**2.342**	11.11	**2.227**	.309	2.153	.537	.197	**.668**	1.776	11 31
Lucerne (alfalfa),	4	6.26	**2.075**	6.82	**1.461**	.814	2.211	.406	.078	**.526**	.513	9 40
Bokhara clover,	2	7.43	**1.975**	7.70	**1.832**	.114	1.784	.347	.023	**.558**	.057	9 49
Blue melilot,	1	8.22	**1.919**	13.65	**2.796**	.270	1.449	.260	.349	**.544**	4.008	10 34
Sainfoin,	1	12.17	**2.630**	7.55	**2.020**	.540	1.160	.430	.040	**.760**	.470	12 19
Sulla,	2	9.39	**2.460**	–	**2.093**	.223	2.497	.350	.114	**.453**	.614	11 37
Lotus villosus,	2	11.52	**2.095**	8.23	**1.807**	.499	2.220	.476	.112	**.594**	.976	9 91
Soja bean,	2	6.30	**2.320**	6.47	**1.079**	.148	2.760	1.178	.115	**.667**	.977	9 97
Cow pea,	1	9.00	**1.635**	8.40	**.913**	.122	2.696	.688	.046	**.527**	.832	7 25
Small pea,	1	5.80	**2.497**	–	**1.990**	.469	1.373	.276	.138	**.592**	1.081	11 52
Flat pea (*Lathyrus sylvestris*),	1	8.90	**3.514**	–	**2.340**	–	1.631	.454	.179	**.820**	1.830	15 69
Serradella,	2	7.39	**2.697**	10.60	**.652**	.656	2.545	.461	.066	**.777**	.590	11 97
Scotch tares,	1	15.80	**2.964**	–	**3.004**	.238	1.698	.354	.460	**.815**	4.062	14 49
Spring vetch,	1	8.21	**2.204**	–	**2.760**	–	1.710	–	–	**.740**	.510	11 48
Vetch and oats,	3	9.91	**1.299**	9.58	**1.349**	.420	.663	.265	.098	**.560**	.521	6 59
Soja-bean straw,	1	13.00	**.714**	–	**1.060**	–	.436	.469	.035	**.259**	.218	3 92
Millet straw,	1	13.45	**.690**	–	**1.760**	–	–	–	–	**.180**	.580	4 63
White daisy,	1	9.65	**.279**	6.37	**1.253**	.164	1.302	.191	.032	**.435**	1.110	2 78
Dry carrot tops,	1	9.76	**3.130**	12.52	**4.883**	4.028	2.089	.667	.118	**.612**	.098	16 94
Barley straw,	2	10.01	**1.125**	5.30	**2.408**	.183	.572	.180	–	**.216**	2.380	7 18

* See note on page 439.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	8	87.82	.229	1.13	.440	.091	.049	.033	.004	.092	.020	$1 37
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 40
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 26
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 17
Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 33
Turnips,	4	89.73	.171	1.01	.379	.078	.089	.027	.009	.115	.112	1 10
Carrots,	3	89.03	.155	9.22	.461	.062	.067	.023	.009	.090	.040	1 23
Parsnips,	1	80.34	.217	-	.617	.006	.088	.045	.005	.187	.019	1 63
Potatoes,	4	80.07	.293	.99	.510	.022	.015	.035	.002	.076	.029	1 11
Artichokes,	1	77.49	.460	-	.484	-	-	-	-	.168	.039	2 31
Japanese radish (*merinia*),	1	93.26	.081	-	.281	-	-	-	-	.047	-	0 64
Japanese radish (*niyas hige*),	1	92.58	.077	-	.338	-	-	-	-	.050	-	0 79
IV. Grains.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	7 52
Corn and cob meal,	29	8.96	1.409	-	.472	.059	.018	.176	.011	.571	.430	6 02

Oat kernels,	1	9.04	2.100	-	-	-	-	-	-	-	-	-
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	22 63
Red adzinki beans,	1	14.82	3.240	-	1.540	.035	.090	.210	.180	.940	.050	14 07
White adzinki beans,	1	16.90	3.330	-	1.480	.190	.130	.220	.021	.970	.130	14 14
Saddle beans,	1	12.38	2.120	-	2.130	.020	.250	.430	.032	1.520	.250	11 28
Daidzu beans,	1	11.53	5.520	-	1.960	.210	.220	.400	.050	1.480	.280	22 96
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	7 16
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	8 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	5 51
Cranberries,	1	89.41	.075	-	.097	-	.018	.013	.005	.028	-	0 49
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
V. Flour and Meal.												
Corn meal,	3	14.13	1.920	1.42	.337	.064	.034	.187	.015	.714	.060	7 80
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	7 22
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.069	6 46
Wheat flour,	2	12.14	2.020	1.22	.359	-	.170	.050	-	.352	-	8 89
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	12 69
Soja-bean meal,	1	10.80	5.89	-	2.230	-	-	-	-	1.570	.280	24 64
Peanut meal,	1	8.00	7.84	-	1.540	-	-	-	-	1.270	-	-
VI. By-products and Refuse.												
Linseed meal, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 98
Linseed meal, new process,	5	7.96	5.828	5.04	1.246	.823	.663	.655	.062	1.692	.345	24 26

* See note on page 439.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
VI. By-products and Refuse — Concluded.												
Cotton-seed meal,	19	8.52	6.577	6.49	1.725	.291	.587	.589	.020	2.393	.322	$26 84
Wheat bran,	8	11.07	2.620	6.44	1.579	.159	168	.899	.019	2.461	.182	13 37
Wheat middlings,	2	10.15	2.745	2.30	.750	.110	.200	.210	-	1.245	-	11 67
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	8 59
Rye feed,	1	9.63	1.950	-	.980	-	-	-	-	1.561	-	9 46
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	-	18 28
Gluten feed (Buffalo),	5	8.15	3.716	-	.064	-	-	-	-	.342	.160	13 45
Gluten meal (Chicago),	1	9.33	5.380	-	.071	-	-	-	-	.380	-	-
Gluten meal (King),	1	7.78	5.690	-	.079	-	-	-	-	.690	-	-
Distillery feed (Atlas mills),	1	11.21	5.300	-	.160	-	-	-	-	.230	-	-
Spent brewers' grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	11 36
Proteina,	1	10.06	2.970	-	.570	-	-	-	-	1.000	-	12 02
Damaged wheat,	1	13.10	2.260	-	.505	-	-	-	-	.831	-	9 30
Louisiana rice bran,	1	10.25	1.430	-	.840	-	-	-	-	1.710	-	7 64
Glucose refuse,	1	6.71	3.370	-	.090	-	-	-	-	.610	-	12 50

Cocoa dust,	1	7.10	2.299	6.350	.630	-	.630	-	-	1.340	-	10 08
Broom-corn waste (stalks),	1	10.37	.870	4.700	1.858	-	.212	.170	-	.460	1.000	5 55
Cotton hulls,	3	10.63	.750	2.610	1.080	-	.200	.260	-	.180	.060	3 99
Peanut feed,	2	9.99	1.460	-	.790	-	-	-	-	.230	-	-
Peanut husks,	1	12.98	.800	-	.480	-	-	-	-	.130	-	-
Meat meal,	1	8.00	11.210	-	.300	-	-	-	-	.730	-	-
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 96
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 48
Palmetto roots,	1	11.51	.540	3.930	1.380	.345	.045	.004	.017	.157	.410	3 57
Buckwheat hulls,	1	11.90	.490	-	.521	-	.247	.236	.020	.073	.066	2 36
VII. Dairy Products.												
Buttermilk,	1	91.13	.510	.810	.046	-	.045	-	-	.041	-	1 88
Skim-milk,	22	90.30	.565	.787	-	-	-	-	-	-	-	-
Whey,	1	93.68	.102	-	.0723	-	-	-	-	.173	-	0 62

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* See note on page 439.

C. Analyses of Fruits.

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, ...	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, ...	1878.	10.11	1.025	15	1.70	-	-	-‖
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.

† Picked October 9.

‡ Picked September 7.

§ Free acid, 2.25 per cent.

‖ Free acid, 2.43 per cent.

¶ In pulp, kept ten days before testing.

C. Analyses of Fruits — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord,	July 17,	1.0175	31	8.30	.645	7.77	-
Concord,	July 20,	1.0150	31	8.10	.625	7.72	216
Concord,	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord,	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord,	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord,	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord,	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape,	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape,	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape,	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape,	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape,	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific,	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling,	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona,	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed),	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam,	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder,	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware,	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak,	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella,	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling,	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack,	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba,	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder,	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak,	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord,	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord,	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan,	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape,	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled),	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled),	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure $Na_2\ CO_3$ in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled, .	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled, . .	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled, . . .	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled, ...	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled, . . .	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled, ...	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled, . . .	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled, ...	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled, ...	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled, ...	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled, . . .	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled, ...	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled, . . .	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled, ...	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled, . . .	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled, ...	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 PARTS OF GRAPES CONTAINED —			
		Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled, . . .	Sept. 23,	–	84.69	6.24	.75
Concord, girdled, ...	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled, . . .	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled, ...	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled, . . .	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled, ...	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled, . . .	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled, . . .	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled, ...	Oct. 9,	.54	85.15	9.12	.74

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* One part of pure Na_2CO_3 in 100 parts water.

C. *Analyses of Fruits* — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	–	–	8.03	–	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	–	–	13.51	–	Fertilized.
Wild Purple Grape Juice, .	"	–	1.045	16	8.22	9 840	Unfertilized.
Wild Purple Grape Juice, .	"	–	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	–	–	–	–	Unfertilized.
Wild White Grape Berries, .	"	21.65	–	–	–	–	Fertilized.
Wild White Grape Juice, .	"	–	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	–	–	–	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	–	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED —						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit),	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice,	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice,	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp,	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds,	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes,	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,*	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,†	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Concord Grapes, 1891,‡	.55	49.76	–	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit),	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple,	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),‖	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines,	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit),	.18	47.96	6.58	18.58	6.78	–	14.27	–
Cranberry vines,	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red,	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white,	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound,	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,¶	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound,	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,¶	–	15.67	–	64.23	10.28	1.45	8.37	–
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems,	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots,	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions,	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

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* With tendrils and blossoms.

† One year old.

‡ Nitrogen in dry matter, .96 per cent.

§ Wilder.

‖ Downing.

¶ Yellows.

** Nitrogen in dry matter, 1.15 per cent.

D. Analyses of Sugar-producing Plants.

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	¾ to ⅞	15.50
II. Vilmorin, ...	Saxony, .	¾ to 1	15.61
I. White Imperial, ...	Saxony, .	¾ to 1¾	14.20
II. White Imperial, ...	Saxony, .	1¾ to 2	10.27
New Imperial, ...	Saxony, .	1¼ to 1¾	13.80
I. White Magdeburg, ...	Saxony, .	1½ to 2	13.10
II. White Magdeburg, ...	Silesia, .	1½ to 1¾	10.06
Quedlinburg, ...	Saxony, .	1½ to 1¾	13.44
White Silesian, ...	Silesia, .	1¼ to 1½	9.72

D. *Analyses of Sugar-producing Plants* — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure, ...	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, ...	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872–73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight, * . .	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight, * . .	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,* . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,* .	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,* . . .	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,* . . .	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,† . . .	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 Parts of Cane contained —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.
October,	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70	
October,	Kansas orange, green, . . .	80.67	2.38	3.63	6.01	
October,	New orange, green, ...	78.30	2.96	3.85	6.81	
October,	Honduras, green, ...	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,† . . .	1.052	–	4.85	5.70	20.38
Common sweet corn,‡ . . .	1.035	–	6.60	None.	–
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	–
White-flesh water-melon, . .	1.025	18	2.91	2.16	–
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	–
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖ . . .	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	–
Nutmeg musk-melon,** . .	1.030	19	2.50	1.43	–

* Tassels appearing.

† Ears ready for the table.

‡ Kernels somewhat hard.

§ Fully ripe.

‖ Not ripe.

¶ Ripe.

** Over-ripe.

E. Analyses of Dairy Products.

	Analyses.	SOLIDS.			FAT.			CURD.			SALT.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	1,889	18.27	10.20	13.47	7.54	1.72	4.14	-	-	3.20	-	-	-	.70
Skim-milk,	348	10.48	7.68	9.48	1.02	.05	.32	-	-	3.53	-	-	-	.80
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	197	32.78	18.12	26.10	25.00	10.53	17.66	-	-	-	-	-	-	.62
Butter,	25	92.89	87.05	89.11	89.05	81.43	83.95	.89	.51	.66	6.45	3.46	4.74	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. *Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	-	-	-	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	-	.090	.070	.070	-	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	-	-	-	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	-	-	-	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	-	-	-	
Solar salt from Kansas,	4.950	93.060	1.220	-	.240	.350	.180	-	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	-	.080	.390	None.	-	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	-	-	-	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	-	-	-	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	-	.614	.041	-	-	-	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	-	.060	-	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	-	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	-	-	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	-	-	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	-	-	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	-	-	.072	
Ashton salt (sent on),	.760	97.650	1.430	-	.060	-	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	-	-	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	-	-	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	-	-	.700	
Royal salt,	.880	97.877	1.108	.016	.010	-	-	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	-	-	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	-	-	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	-	-	-	
Bradley salt,	.200	98.575	1.185	.029	.007	-	-	-	
Higgins' Eureka salt,	.855	98.891	.906	.293	.055	-	-	-	
Worcester refined salt,	.565	97.935	1.376	.097	.027	-	-	-	

F. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

VI. TABLES OF THE DIGESTIBILITY OF AMERICAN FEED-STUFFS.

EXPERIMENTS MADE IN THE UNITED STATES.

COMPILED BY J. B. LINDSEY.

I. EXPERIMENTS WITH RUMINANTS.

II. EXPERIMENTS WITH SWINE.

DEC. 31, 1894.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	4	7	47.0—61.1 53	48.4—62.3 54	37.2—56.8 46	34.6—61.1 54	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	10	22	58	58	53	61	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	4	14	54—62 58	- -	56—66 60	44—57 49	56—64 59	56—63 59
Hay of vetch and oats,	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom),	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56

Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	–	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	– –	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soja-bean hay,	1	2	61.9—62.7 62	– –	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	– –	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70
Cow-pea-vine hay (fair quality),	1	2	– 59	– –	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	– 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	1	2	56.8—65.4 62	– –	42.6—58.1 50	35.1—54 46	66.5—70 69	63.4—73.6 69
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2	–	–	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	–	–	43	48	69	72

* Below ten per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Corn Fodders (partially Air Dry).								
Corn stover (whole plant),	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59
Corn stalk (below ear),*	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),*	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,*	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),*	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 55	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	5	10	63—70 68	- -	43—61 54	72—82 78	43—61 53	68—81 76
Average both kinds,	-	-	70	-	65	74	59	74
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66

Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cat's-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	- -	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay, *	1	1	55	-	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	- -	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	-	64	46	14	65
Cotton-seed hulls,	4	13	35—47.5 41	- -	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	- -	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	-	64	78	61	76
Dent corn fodder (glazing),	5	9	67	-	51	78	54	75

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* Made at Maryland Experiment Station. It will be noticed that the coefficients of protein digestibility are very much below those obtained in other experiments. The animals were fed but six pounds each per day, with no other food, and it is probable that the metabolic nitrogen products excreted were in a measure at least the cause of the low results obtained.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent).	Crude Cellulose (Per Cent).	Crude Fat (Per Cent).	Crude Protein (Per Cent).	Extract Matter (Per Cent).
Green Fodders — Concluded.								
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	87—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Early amber sorghum (just after blossom),	1	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Soiling rye (formation of head),	1	2	73.2—74 74	- -	78.9—80.4 80	73.6—74.8 74	78.6—79.7 79	69.7—71.4 71
Soiling clover (late blossom),	1	2	64.9—67.3 66	- -	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78
Hungarian grass (probably in bloom),	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66

Corn Silage.								
Dent silage (immature),	4	10	60—68 64	- -	71—78 71	64—85 72	42—65 52	60—70 66
Dent silage (milk),	4	12	60—74 65	- -	45—80 64	78—90 87	45—63 52	63—73 69
Dent silage (average of both),	8	23	65	-	68	80	52	67
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	3	8	68—78 75	66—80 77	75—78 77	- 80	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 65	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature),	1	1	-	-	59	86	45	71
Same (cooked),	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soja-bean ensilage,	1	2	52.2—65.8 59	- -	47.1—62.5 55	66.4—77.3 72	71.3—80.2 76	45.9—58.2 52
Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Roots, Tubers, etc. — Concluded.								
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2 - 117 100	82.5 - 92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains.								
Corn meal (maize),	2	5	83—98 88	- -	- -	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	- -	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	- -	65—86 76	- 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	- -	62—69 66	68—75 72	44—50 47	50—53 51
Soja-bean meal,	1	2	78—86 82	- -	48—94 71	81—90 86	90—92 91	76—77 76
By-products.								
Cotton-seed meal,	2	6	67—82 76	- -	- 32	87—100 93	83—96 88	44—75 64
Gluten meal,	1	2	85—90 87	86—92 89	- 33	86—90 88	83—90 87	88—94 91

Chicago gluten meal,	1	2	92–94 93	– –	4–39 22	96–98 97	89–92 90	96–97 97
King gluten meal,	1	2	84–87 85	– –	– –	92–98 95	– 92	82–86 84
Average gluten meals,	3	6	88	–	–	93	90	91
Buffalo gluten feed (one lot),	1	2	76–80 78	– –	40–46 43	81–82 81	84–86 85	78–84 81
Buffalo gluten feed (another lot),	1	2	89–91 90	– –	91–105 100	93–96 94	89–89 89	89–90 89
Peoria gluten feed,	1	2	84–87 86	– –	59–97 78	76–82 79	81–85 83	90–90 90
Chicago maize feed,	1	2	86–88 87	– –	78–86 82	91–92 92	85–86 85	86–90 88
Winter-wheat bran,	1	3	61–66 64	– –	5–56 28	53–80 65	78–79 78	70–72 71
Spring-wheat bran,	1	2	62–63 63	– –	22–25 24	76–76 76	78–82 80	70–71 70
Average all wheat brans,	4	9	61	63	22	71	78	69
Wheat middlings,*	1	2	72.6–72.2 75	75.1–79.3 77	– –	84.1–86.1 85	78.4–79.4 79	80.7–84.5 83
Wheat middlings,†	1	2	79.48–85.63 83	– –	32.57–40.06 36	81.71–87.98 85	81.83–87.75 85	84.43–91.08 88
New-process linseed meal,	1	3	77–83 80	– –	49–90 74	90–102 94	83–88 85	85–87 86
Old-process linseed meal,	1	3	75–82 79	– –	38–71 57	85–92 89	86–93 89	76–79 78
Atlas meal,	1	2	80–80 80	– –	95–116 106	90–92 91	73–73 73	84–85 84

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* Jordan.

† Very fine and quite light in color.

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.								
Rye meal,	1	2	85—90 87	- -	- -	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	- -	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	- -	50—55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	- -	65—66 65	44—56 50	13—22 17	60—60 60
II. EXPERIMENTS WITH SWINE.								
Maize kernels (whole),	1	1	83	83	33	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat shorts,	1	2	74—79 77	- -	25—48 37	- -	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	- -	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins 87 *d*, 80 *c*, 81 and 97 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletin No. 26 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletin No. 20 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

METEOROLOGY.

C. H. JOHNSON.

1894.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness, are recorded each day, at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same time. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the New England Weather Service at Boston.

The most conspicuous meteorological phenomena of the past year (1894) will be briefly considered here, while the following tables will show the average monthly temperature, precipitation, prevailing direction of the wind, etc.

The mean temperature for January, February and March, viz., 28.03°, was above the normal, and 6.15° above that for the first three months of 1893. The precipitation, viz., 6.28 inches, was about 4 inches below normal, and 5.59 inches below that for the same season in 1893.

There were 4 inches of snow on the ground at the beginning of the year, but this had nearly all disappeared by the 15th of January. On the 27th of January 5 inches of snow fell, and on the 29th and 30th there was a storm giving 10 inches, so there were 13 inches of snow on the ground at the end of the month.

The daily mean temperature for January, viz., 25.43°, was about 5° above the normal, and was 10.95° above that of January, 1893, as recorded at this station. The precipitation was much below the normal.

The mean temperature for February, viz., 19.68°, was about 4° below the average. On the morning of the 25th the minimum reading was — 18°. The mean temperature for the 24th was — 1° and for the 25th — 2.5°, these being the two coldest days of the year. The precipitation was much below the normal, but the ground was well protected with snow during the greater part of the month.

The month of March was warm and dry. The daily mean temperature, viz., 39°, was nearly 10° above the normal, and was 9.4° above that of March, 1893. The precipitation, viz., 1.68 inches, was nearly 2 inches below the average.

April was also characterized by being unusually warm and pleasant. The daily mean temperature, viz., 45.6°, was about 2° above the normal. The precipitation, viz., 1.60 inches, was 2 inches below the average for that month. There was a storm on the 8th giving 4 inches of snow, and one on the 12th and 13th giving 2 inches. This was the last snowfall of the season. April being so warm and dry, farmers were enabled to get most of their land in condition for planting, and some had planted potatoes, onions, mixed forage crops, etc., by the 25th.

The mean temperature for May was about the average. The mercury reached the freezing point several times. On the morning of the 15th the minimum reading was 28°. The precipitation was about normal, but most of it occurred during the last week of the month. The dry weather during the first two weeks of the month retarded the germination of seeds and growth of plants. Frosts on the 15th and 22d injured those crops that were up, and damaged fruit, especially on low lands. The frost of the 22d was the last of the season.

The mean temperature for June, viz., 67.53°, was about 3° below the normal. The rainfall was 5 inches below the average, and most of it occurred during the first and last part of the month, while the middle was hot and dry. The month was favorable for the growth of all crops. Haying was quite general by the 15th.

The month of July was hot and dry. The daily mean temperature, viz., 71.9°, was about 4° above the normal, while the rainfall, viz., 1.60 inches, was nearly 3 inches below, and 1 inch below that for July, 1893. The absolute maximum temperature was 98°, occurring on the 20th.

August was extremely dry. The mean temperature was about normal, while the precipitation, viz., 32 inches, was nearly 4 inches below.

The continued drought of July and August caused great damage to farmers, seriously injuring crops, drying up wells and springs, so that in many instances the water supply was almost or entirely shut off.

The first frost of the season occurred on the 22d of August, and slightly injured vegetation on low lands.

The mean temperature for September and October was about 3° above normal, and the rainfall about normal. These months were favorable for the ripening and harvesting of crops.

The mean temperature for November was about normal, while the precipitation was 5 inches below. A trace of snow fell on the 5th, which was the first of the season.

For December the mean temperature was about normal, while the precipitation was slightly below.

The precipitation has not been sufficient to fill up the wells and springs, and now there is a scarcity of water in many localities.

Summary of Meteorological Observations, 1894.

	TEMPERATURE, DEGREES FAHRENHEIT.														
	7 A.M.	2 P.M.	9 P.M.	Mean Maximum.	Mean Minimum.	Mean.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	Greatest Daily Range.	Date.	Least Daily Range.	Date.	Mean Daily Range.
January,	21.13	30.83	25.64	34.84	16.39	25.43	45.00	22d	0	29th	34.00	2d	6.00	5th	18.45
February,	16.93	28.53	21.64	30.93	8.85	19.68	46.00	8th	—18.00	25th	47.00	17th	10.00	9th	22.08
March,	34.54	47.64	38.00	49.51	28.48	39.00	73.00	19th	20.00	4th, 26th	32.00	18th	11.00	14th, 29th	21.03
April,	41.63	55.00	44.76	56.80	34.40	45.60	77.00	27th	14.00	3d	40.00	16th	5.00	8th	22.40
May,	52.48	66.42	54.03	69.48	43.45	56.45	84.00	1st, 2d	28.00	15th	42.00	14th	10.00	31st	26.03
June,	63.76	76.90	65.76	79.20	55.86	67.53	93.00	17th	37.00	8th	39.00	14th	11.00	29th	23.34
July,	67.50	82.00	70.40	84.80	59.10	71.90	98.00	20th	48.00	10th, 11th, 23d	34.00	23d	14.00	5th	25.70
August,	61.40	78.30	65.10	80.40	53.50	66.90	91.00	24th	36.00	22d	42.00	22d	9.00	30th	26.90
September,	57.16	73.10	62.30	76.00	51.46	63.73	91.00	10th	32.00	26th	40.00	13th	8.00	19th	24.53
October,	45.70	58.90	48.30	60.20	40.40	50.30	73.00	20th	29.00	19th	33.00	20th	5.00	25th	19.87
November,	31.80	39.46	33.46	41.70	25.83	37.10	65.00	3d	9.00	20th	27.00	2d	6.00	8th, 9th	15.86
December,	21.48	32.93	24.84	34.67	15.64	25.16	49.00	15th	—7.00	28th, 30th	36.00	6th	6.00	8th, 9th, 12th	19.03
Sums,	515.51	670.01	554.23	698.58	433.36	569.78	-	-	-	-	-	-	-	-	265.22
Means,	42.98	55.83	46.18	58.21	36.11	47.48	-	-	-	-	-	-	-	-	22.10

Summary of Meteorological Observations, 1894.

	PRECIPITATION, INCHES.					WIND.	CASUAL PHENOMENA.—DATES.			
	Total Amount.	Date of Greatest Fall.	Total Snowfall.	Depth of Snow the 15th.	Depth of Snow at End of Month.	Prevailing Direction.	Thunder-storms.	Solar Halos.	Lunar Halos.	Aurora.
January,	2.43	29, 30,	20.20	.50	13.00	N. W. and N.	– –	9, 15, 26,	13,	3,
February,	2.17	9, 10,	18.25	13.00	5.00	N. W.	– –	5, 12, 17, 25,	14, 17, 18, 20,	22, 23,
March,	1.68	22, 23,	2.00	2.00	-	S. W.	– –	12, 13, 15, 20, 22,	12, 20,	2, 30,
April,	1.60	21, 22,	6.00	3.00	-	N.	27, 28,	1, 16, 30,	16, 18,	-
May,	3.80	18, 19,	-	-	-	S. W.	2, 6, 18, 19,	14, 16,	16,	-
June,	3.43	2, 3,	-	-	-	S. W.	18, 19, 27, 30,	-	14,	-
July,	1.60	21, 22,	-	-	-	S. W. and S.	3, 4, 6, 14, 17, 21, 25, 29,	-	22,	-
August,	.32	3,	-	-	-	S.	3, 15, 19, 30,	-	-	-
September,	4.11	19, 20,	-	-	-	S.	10, 16, 20,	-	-	-
October,	4.40	9, 10,	-	-	-	S.	– –	-	-	-
November,	3.09	3,	3.00	-	-	N.	– –	-	-	-
December,	3.45	11, 12,	22.00	-	7.00	N.	– –	19, 24, 26,	7, 10, 19,	-
Sums,	32.08	-	71.45	-	-	-	– –	-	-	-

SUMMARY OF METEOROLOGICAL OBSERVATIONS, 1894.

January, February, March, April.

	1893.	Date.	1894.	Date.
Mean temperature,	26.89°	-	32.43°	-
Absolute maximum temperature,	66.00°	April 1,	77.00°	April 27.
Absolute minimum temperature,	—13.00°	Jan. 17,	—18.00°	Feb. 25.
Mean monthly range,	19.34°	-	20.99°	-
Total precipitation (inches),	15.53	-	7.88	-
Total snowfall (inches),	71.25	-	46.45	-
Last snowfall (inches),	trace	April 21,	2.00	April 12.

May, June, July, August.

Mean temperature,	64.47°	-	65.69°	-
Absolute maximum temperature,	94.00°	Aug. 10,	98.00°	July 20.
Absolute minimum temperature,	31.00°	May 8,	28.00°	May 15.
Mean monthly range,	24.12°	-	25.52°	-
Last frost,	-	May 8,	-	May 22.
Total precipitation (inches),	13.38	-	9.15	-

September, October, November, December.

Mean temperature,	42.29°	-	44.07°	-
Absolute maximum temperature,	81.00°	Sept. 10,	91.00°	Sept. 10.
Absolute minimum temperature,	—13.00°	Dec. 14,	—7.00°	Dec. 28, 30.
Mean monthly range,	21.82°	-	19.25°	-
First frost,	-	Sept. 3,	-	Aug. 22.
Total precipitation (inches),	14.31	-	15.05	-
First snowfall (inches),	trace	Nov. 4,	trace	Nov. 5.
Total snowfall (inches),	15.25	-	25.00	-

Entire Year.

Mean temperature,	44.55°	-	47.39°	-
Total precipitation (inches),	43.22	-	32.08	-
Total snowfall (inches),	86.50	-	71.45	-

LIST OF EXCHANGES.

Reports and Bulletins of the United States Department of Agriculture, Washington, D. C.
Reports and Bulletins of the Agricultural Experiment Stations of the United States.
Bulletins of the State Board of Agriculture, Boston, Mass
Bulletins of the Massachusetts Horticultural Society.
The American Cultivator, Boston, Mass.
The Holstein-Friesian Register, Boston, Mass.
Farm-Poultry Monthly, Boston, Mass.
Massachusetts Ploughman, Boston, Mass.
New England Farmer, Boston, Mass.
The Home and Mart, East Boston, Mass.
The American Nation, Boston, Mass.
New England Homestead, Springfield, Mass.
Farmers' Advocate, St. Albans, Vt.
Mirror and Farmer, Manchester, N. H.
New York Weekly World, New York, N. Y.
German Agricultural and Horticultural Journal (German), New York, N. Y.
American Agriculturist, New York, N. Y.
The Florists' Exchange, New York, N. Y.
Vick's Magazine, Rochester, N. Y.
The American Analyst, New York, N. Y.
Naturalist Monthly Bulletin, Philadelphia, Pa.
The Practical Farmer, Philadelphia, Pa.
The Farm Journal, Philadelphia, Pa.
The National Stockman and Farmer, Pittsburgh, Pa.
Contributions from the Botanical Laboratory of the University of Pennsylvania, Philadelphia, Pa.
Veterinary Magazine, Philadelphia, Pa.
Dorset Quarterly, Washington, Pa.
Chester County Village Record, West Chester, Pa.
Maryland Farmer, Baltimore, Md.
Baltimore Weekly Sun, Baltimore, Md.
Creamery and Dairy, Waterloo, Iowa.
The Agricultural Epitomist, Indianapolis, Ind.
The New Agricultural Era, Indianapolis, Ind.
The Clover Leaf, South Bend, Ind.

The Orange Judd Farmer, Chicago, Ill.
The Western Swineherd, Geneseo, Ill.
Elgin Dairy Report, Elgin, Ill.
The Dairy Messenger, Chicago, Ill.
The Dairy World, Chicago, Ill.
German Agricultural and Horticultural Journal, Chicago, Ill.
Detroit Free Press (weekly), Detroit, Mich.
University Record, Ann Arbor, Mich.
Farmers' Home Weekly, Dayton, Ohio.
American Grange Bulletin, Cincinnati, Ohio.
Journal of Columbus Horticultural Society, Columbus, Ohio.
The Louisiana Planter, New Orleans, La.
Hoard's Dairyman, Fort Atkinson, Wis.
Hospoda (Bohemian Journal), Omaha, Neb.
The Industrialist, Manhattan, Kan.
The Home and Farm, Louisville, Ky.
The Industrial American, Lexington, Ky.
Journal of the Elisha Mitchell Scientific Society, Chapel Hill, N. C.
Southern Cultivator, Atlanta, Ga.
Monthly Florida Bulletin, Tallahassee, Fla.
West American Scientist, Los Angeles, Cal.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Journal of the Geographical Society of California, San Francisco, Cal.
Publications of the Department of Agriculture, Quebec, Canada.
The Journal of Agriculture, Montreal, Canada.
Bulletins of the Central Experiment Farm, Ottawa, Canada.
Industrial Journal of Agriculture, Montreal, Canada.
Agricultural Student's Gazette, Cirencester, England.
Journal of Microscopy and Natural Science, Bath, England.
Lawes and Gilbert, Rothamstead, England.
British Dairy Farmers' Association, London, England.
British Dairy Farmer and Dairy World, London, England.
Landwirtschaftliche Blätter, Cassel, Germany.
Jahresbericht der Samen Control Station, Vienna, Austria.
Berichte der Landwirtschaftliche Verssuchstation, Halle, Germany.
Bulletins Ministere de l'Agriculture, Paris, France.
Bulletins of the College of Agriculture, Tokio, Japan.
Bulletins of the Department of Agriculture, New South Wales, Australia,
Agricultural Gazette, New South Wales, Australia.
Bulletins of the Department of Agriculture, Brisbane, Queensland, Australia.
Garden and Field Journal, South Australia.
Journal of the Council of Agriculture, Hobart, Tasmania.
Relatorio, Annual da Estacao Agronomica de Campinas, Sao Paulo Brazil.
Ragguagli, Laboratorio Chimico Agrario di Bologna, Bologna, Italy.
Reglamento, etc , Estacion Agronomica del Instituto Agricolo de Alfonso XII., Madrid, Spain.
Bulletins, Sculola Superiore d' Agriculture, Portugal.

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